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Have You a Job Like This

That you are Proud of?

MOST electrical men take a distinct pride in a ship-shape job and they usually have one or two pet installations that they like to show when a visitor comes around. And, too, they often use the back stairs or the elevator to hurry past any shabby looking installations there may be. These may be in a dark corner or an out-of-the-way place but they are so prominent in the consciousness of the man who knows they are there that he feels he has to make all sorts of apologies for them. Yet they stay somehow until a house cleaning or change in layout comes along.

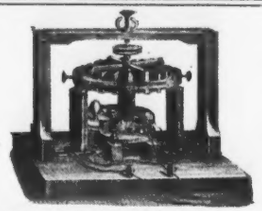
It's a peculiar thing but some kinds of plants have more of these shabby installations of leads to motors, makeshifts in installation of switches and runs of wiring than others. In the foundry and the cement mill the dust and dirt seems to be the evident apologies for these conditions. In way of contrast I have picked out a picture of an installation in a textile mill which any electrical man might be proud of. And it's a handy place for excuses for messy wiring at that, as well as a good chance to show how an all-conduit, enclosed-terminal job may be made a safe and permanent installation.

But I don't mean to say that the electrical man is always to blame for messy wiring. We still have motors with a round hole in the base from which three wires invite a drip loop connection or a day's work figuring out how to fasten one of several hundred conduit fittings, none of which was designed for the place where terminals come out of a motor.

I want to collect a number of photos of good installations and also some of the ones which serve as an alibi for a bad looking installation. Then we will analyze the ways to get around some of the electrical eyesores. I wish you would send me some of both from your plant—I won't tell on you if you send a real bad looking job, so come on with your worst as well as the good ones and I will try and work up a picture series of good and other ways the electrical man does things.

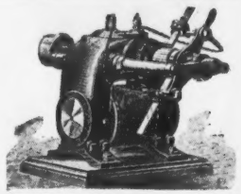
Practical Pete

1845 FROMENT'S MOTOR



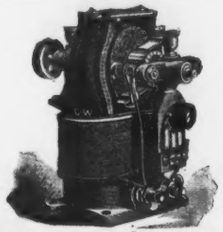
1860 - PACINOTTI'S MOTOR

1890 - U.S. ELECTRIC LIGHTING CO. (WESTINGHOUSE ELECTRIC CO., LESSEES)

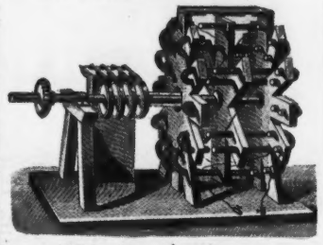


1890 - JENNEY ELECTRIC MOTOR CO

1890 - EDDY ELECTRIC MANUFACTURING CO.



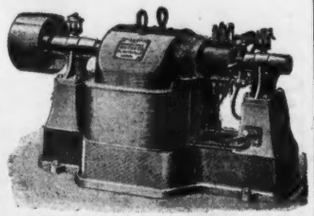
1890 - CROCKER-WHEELER "PERFECTED MOTOR"



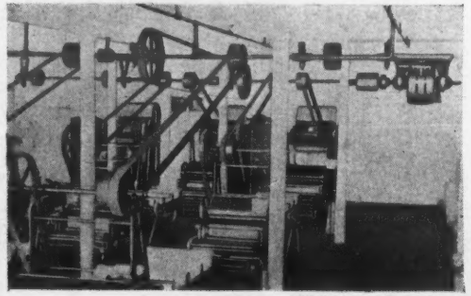
1834 - JACOBI'S MOTOR

Motor History in Pictures

Not quite a century ago (1823) the first crude motor was made by Barlow. It consisted of a copper disk which rotated between permanent magnets. In 1830 Dal Negro made a motor with a vibrating contact which served the purpose of a commutator, but the first rotating commutator was made by Pixii in 1832. It had only two segments. In 1860 the first multiple-segment commutator was made by Pacinotti. In 1856 Siemens developed the shuttle-wound armature. A ring winding was made by Pacinotti in 1860 but the ring winding of Gramme which was used extensively was not developed until 1870. Preceding this, in 1867, the electromagnet was first used for fields. It was in 1880 that more than two poles were first employed in a motor. This same year, 1880, Elihu Thomson invented the open coil which is used today. In 1885 the principle of the rotating field was first applied to motors and about 1890 the squirrel-cage rotor was adopted. Since that time no great developments in principle have been made, but many marked improvements in construction and design have been worked out in the motors of the present day.

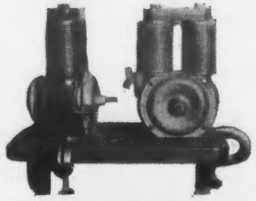


1890 - CONNECTICUT MOTOR CO.



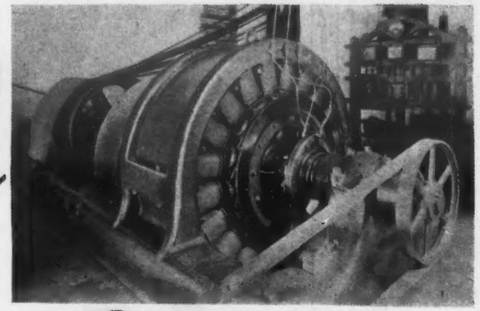
1894 - INDUCTION MOTOR IN COTTON MILL

1895 - SINGLE-PHASE RAILWAY MOTOR



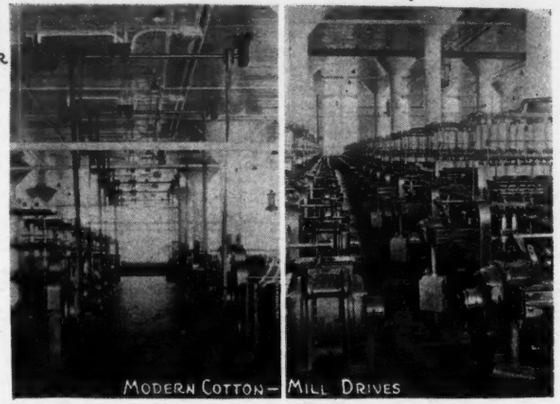
1886 - TWO OF FIRST 100 MOTORS MADE BY C. & C. CO.

1922 - SMALL HOUSEHOLD MOTOR

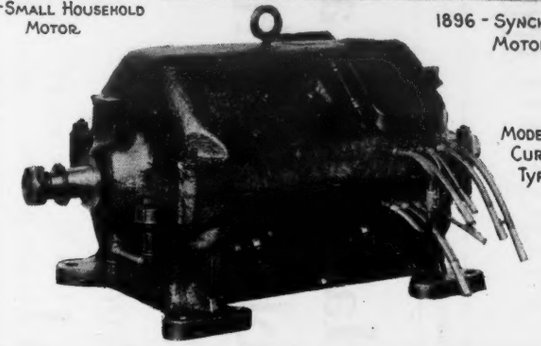


1896 - SYNCHRONOUS MOTOR

MODERN GENERAL-PURPOSE POLYPHASE INDUCTION MOTOR



MODERN COTTON-MILL DRIVES



MODERN DIRECT-CURRENT MILL-TYPE MOTOR

IN THOSE CASES where a good sample coil can not be obtained when rewinding a motor, the schemes explained in this article will make it easy to lay out to scale a drawing of the coil required. By taking dimensions from this drawing you can make a shuttle or a mold of the correct shape for winding coils which will fit correctly in the motor slots. All of the methods described have been successfully used by Mr. Roe who is shop superintendent of the Detroit Service Department of the Westinghouse Electric & Manufacturing Company.

A. C. ROE
Explains Shop

Methods For Laying Out Coils

for D. C. Armatures and A. C. Stators

SOMETIMES a motor comes into a repair shop without coils or with coils which were not properly designed. Again it may be thought that coils of a different type will be more suitable or cheaper than the old coils. When this happens the repair man must make up a design for the new coils. In such a case it is important that they must not be so tight that they require too much pounding to force them into place. On the other hand they must not be so bulky that they will touch the end plates of the motor, or require an unnecessary amount of wire. There is a correct shape of coil for each motor frame. The mold or the shuttle must be built to give this shape. It is not difficult to lay out the dimensions for a mold or shuttle if the job is attacked in a logical manner.

The writer employs methods which can be followed by any intelligent winder who can use a compass and a rule. In applying these methods the necessary measurements are first made on the motor slots and core, then the coil shape is developed and from this are taken the dimensions required in making the mold or shuttle. Five common types of coils are discussed in this article, (1) the flat diamond mush, (2) the mush puller. (3) the bi-polar in-and-out (staggered), (4) the layer-wound puller, and (5) the involute.

The development of the flat diamond mush coil (see Fig. 1) will be taken up first as it is the simplest and least expensive of all coils. It is not, however, satisfactory for all jobs. Before deciding upon the use of a flat mush coil, the following points must be considered: Will the size of wire and the turns required make the coil too hard for the armature winder to shape while winding? If so, the excessive pounding which will be required will be likely to damage the insulation of the coils. As a general rule, it is safe not to use flat diamond mush coils for deep, narrow slots. Such coils are satisfactory if they are nearly square or round. The wire should not be larger than No. 13 B. & S. gage or preferably No. 15. Single-cotton-covered enameled wire should be used and, where space permits, double-cotton-covered enameled wire. Do not put shellac on enameled wire as the alcohol in the shellac has a tendency to soften the enamel.

When in doubt about the choice between flat mush coils or mush puller coils wound in layers, make up a bundle of wires about 10 in. long and containing the number of wires that will be in the coils. Submit this trial bundle to an experienced winder. He can tell whether a flat mush coil will wind without excessive pounding or whether a mush pulled coil will be cheaper and safer, considering the time it will take the winder to shape the pulled coils against the coil pullers.

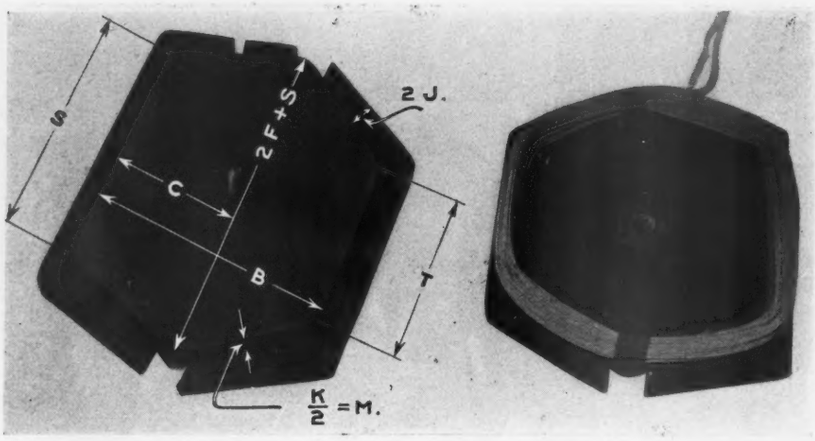


Fig. 1. A mold for a flat diamond mush coil.

The dimensions shown correspond to the dimensions in Fig. 2. At IV of Fig. 2 is a simplified diagram of the mold.

Usually coils for 110-volt and 220-volt motors may be wound in mush type. Where the number of turns in series is large, 440-volt motors can be wound mush. If the number of turns is small, however, a layer-wound coil should be used for 440 volts and such a coil should always be used with higher voltages.

When developing a flat diamond mush coil, first the pitch of the coil must be known and the dimension *B* obtained as shown in II, Fig. 2. If this distance *B* cannot be measured, it may be calculated for rotors as follows:

B=[(Diameter—K)×3.14×pitch] ÷No. of slots.

For stators B=[(Diameter+K)×3.14×pitch] ÷ No. of slots. The value K equals the height of the slot as shown in Fig. 2. This must be measured and the width of the slot must be taken also. The next dimension is W which equals the width of the coil plus the end finger plates.

How to Lay Out Flat Diamond Mush Coils

A flat mush coil can be laid out easily with a rule, a pencil and a compass as shown in Fig. 2. The drawing I, Fig. 2, represents a mush coil in place upon the core; II, Fig. 2, is a side view of the teeth of the rotor; III, Fig. 2, shows how the coil is drawn to dimensions, and IV, Fig. 2, shows what dimensions are required to make the mold for winding the coil. In III the small figures in the circles tell the order in which the lines are drawn.

(1) The first line, for instance, is Y-Y, which is drawn horizontally across the paper. This line is marked by the figure (1) in a circle.

(2) The line X-X is drawn ¼ in. from Y-Y. When the distance between these lines is ¼ in., the top cell will be ½ in. longer than the bottom cell. If the end room is scant, both cells may be made the same length and these two lines will then coincide.

(3) A horizontal line, X'-X' is drawn at a distance T from X-X. This distance T equals the width of the core, W, (see I, Fig. 2), plus ¾ in. The dimension W is the width of the core plus any end finger plates. The straight part of the bottom cell section of the core should project on an average ⅜ in. beyond the iron before being bent. This distance beyond the end of the core should never be less than ¼ in.

(4) Draw horizontal line Y'-Y' ¼ in. from X'-X'.

(5) Draw the vertical line from Y to Y'

(6) Draw the vertical line from X to X' at a distance from (5) equal to *B*. This distance *B* equals the width of the coil measured along the arc as shown in II, Fig. 2. The length of the arc is used instead of the chord to allow sufficient wire for shaping the coil ends and bending them down without touching the iron. This measurement can be made on the machine by means of a piece of string which is afterward measured with a rule.

(7) Draw the center line midway between (5) and (6).

(8) Draw an arc as shown with the radius *R*. This radius *R* equals [coil pitch×(M+J)]÷4. M and J are the coil depth and width as shown in the small figure at I, Fig. 2. The coil pitch equals the number of slots spanned by the coil. In Fig. 2 the coil lies in slots 1 and 8 and therefore the coil pitch equals 7.

(9) Draw an arc with the same radius as the arc (8).

(10) Draw a line from the point *h* just touching arc (9).

(11) Draw another line below just touching arc (8).

(12) Connect *p* with line (5).

(13) Connect *q* with line (5).

This completes the form of the coil. Now it is necessary to take the dimensions of the outline and use these in making the mold. At IV,

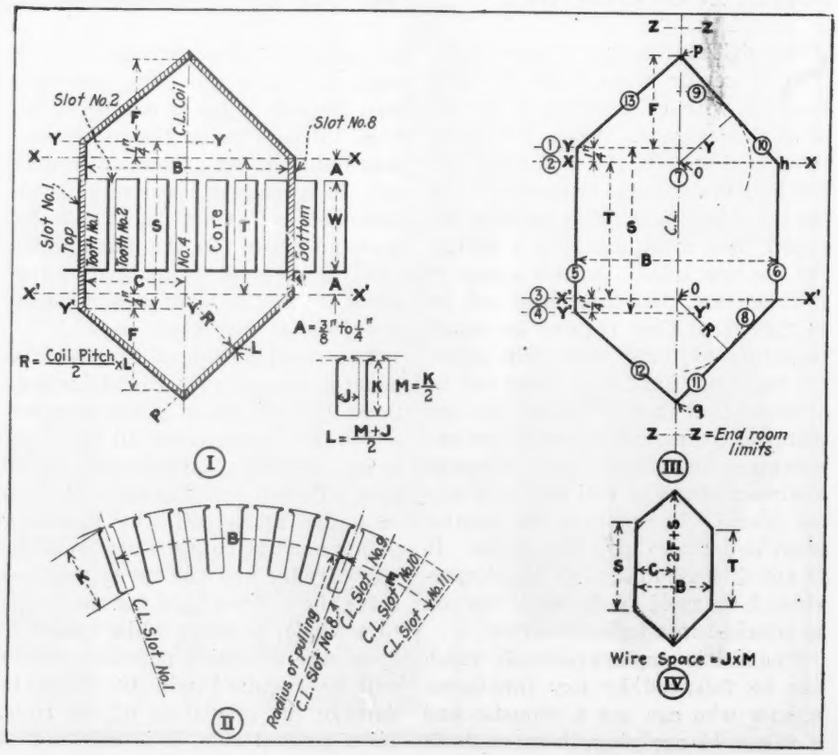


Fig. 2. How dimensions are obtained for laying out a flat diamond mush coil.

I. A coil in place in the slots. II. This shows how the distance *B* is measured half-way down the slot and following the curvature of the laminations. III. This is a diagram which shows the dimensions of the coil. It is drawn after all measurements have been made on the motor or calculated. The lines are drawn in the order indicated by the numbers in the circles. See the article for full directions. After this figure is constructed, a mold is made as shown in Fig. 1. The dimensions needed to make the mold may be seen from the simplified drawing at IV. The wire space, J×M, is obtained from the small drawing in I.

Fig. 2, are shown these dimensions and how a diagram is laid out for making the mold. If the coils are for a direct-current armature (lap or wave winding) and if the leads are brought out at the end of each cell, the length of the leads should be equal to B plus 1½ in. See Fig. 1 for a picture of a mold and a coil of this kind, flat diamond mush.

After a winder has had experience in developing several coils the entire coil need not be drawn, as one-half or end will be enough to determine the dimension *F* in Fig. 2. In fact, it will only be required to draw the right triangle, *p-o-h*, shown in the upper right-hand corner of the coils.

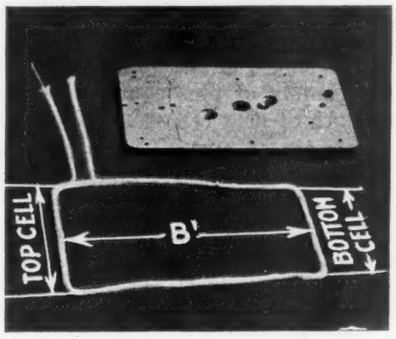


Fig. 3. This is a coil for a bi-polar staggered winding.
Above the coil is the center board of the mold used in winding. It is simple to lay out the dimensions as shown in Fig. 4.

When the Coil Will Be Stiff Mush-Puller Should Be Used

When the size of the wire and the number of turns of the coils make the coils too stiff and hard to form at placing in the machine, a mush-puller coil must be made. To lay out this kind of a coil, proceed in the same manner as described in a flat mush coil. This coil, however, is wound on a shuttle instead of a mold. To find the distance apart of the shuttle pins, take the sum of all the lines ,(5), (6), (10), (11), (12) and (13) and divide this sum by 2. This will be the distance between the center lines of the pins. The radius of pulling for a rotor will be the (diameter—*K*)÷2. For a stator, it will equal the (diameter+*K*)÷2. The angle of pulling is equal to (360 deg.÷number of slots)×(coil pitch). The thickness of the center piece used on the shuttle should be equal to *J* as shown in Fig. 2. If the leads are brought out at the end of each cell, then the length of each lead is equal to *B* plus 1½ in.

Developing a Bi-Polar Staggered Winding

In Fig. 4 is shown how a bi-polar in-and-out or staggered winding coil is developed. Fig. 3 is a photograph of a coil for such a winding. The length of the bottom cell should be just so long that the bend will come beyond the outside of the end plate. The top cell is longer than the bottom by twice the width of the coil, which equals *J*. The dimension *B'* is equal to *B* in II, Fig. 2, plus 3 slots, or *B* plus *E*. Make up three or four coils and try them out before winding a complete set.

Pulled Coils Wound in Layers

The development of the layer-wound pulled coil requires a bit more care than developing the mush coil. Fig. 7 may be used as a guide in developing this type of coil. In I, Fig. 7, are shown the measurements which must be taken from the rotor. Radius 1 is one-half the bore of the stator. Radius 2 is the radius of the rotor. *H* is the distance between the top of the coil and the iron. The distances *a-c* and *d-e* are the height of the coil sides and the thickness of the insulation is shown by the distances *c-d* and *e-f*. In II, Fig. 7, is a coil wound into place on a rotor or stator. The distance *G* is the drop of the coil below the iron and this should never be less than ¼ in. At *A* is the distance the short or bottom cell projects beyond the iron. The width of the iron *W* includes laminations and all ventilation and end plates. The distance *N* is the distance the long or top cell extends beyond the bottom cell. In the table at the bottom of Fig. 7 are given values for *A* and *N* for different voltages.

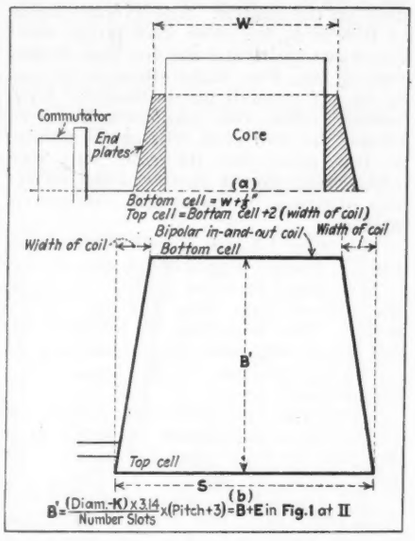


Fig. 4. Dimensions needed to lay out a bi-polar staggered winding.
This is also called an "in-and-out" winding. The distance *B'* equals the pitch of the coil (measured around the arc) plus three slots. This is shown as *B*+*E* in II of Fig. 2. A coil of this kind is shown in Fig. 3.

In laying out a stator coil the first step is to develop a sketch shown in III, Fig. 7. In developing this drawing, the lines are taken in the order shown in the following:

(1) Arc *m-m'* is drawn with a radius equal to one-half the stator bore which is Radius 1 in I, Fig. 7.

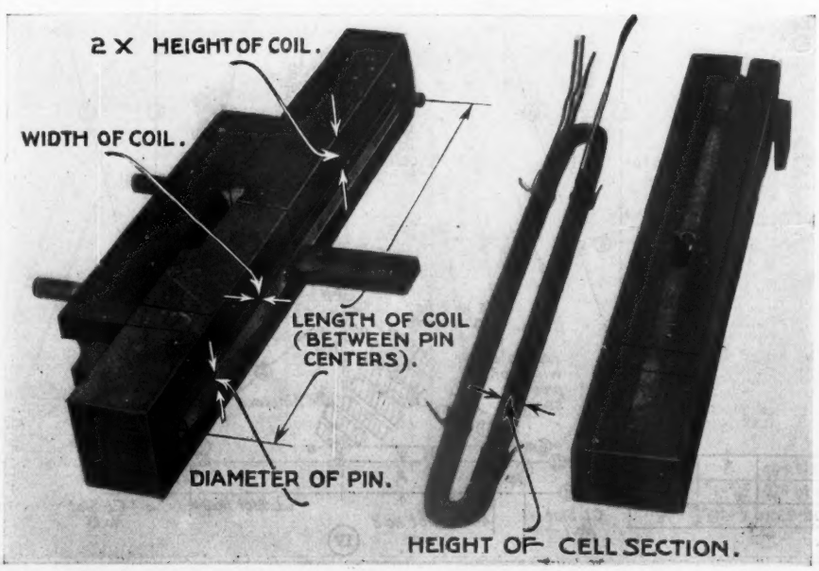
(2) Arc *a-a'* is drawn with a radius equal to *O-a* in I, Fig. 7.

(3) The line *O-a* is drawn (III, Fig. 7).

(4) Measure the angle Ø from line (3). This angle Ø equals (360÷no. slots)×(coil pitch).

(5) Draw the line *O-e*.

Fig. 5. Layer-wound puller coil and shuttle on which it was wound.



(6) Draw the line *O-x* bisecting the angle.

(7) Draw the line *a-u* at right angles to the line (3).

(8) Lay off the distance *a-c* which equals the height of one coil (see *a-c* at I, Fig. 7). From *c* draw *c-v* at right angles to line (3).

(9) Lay off the distance *a'-d* equal to *a-d* in I, Fig. 7. Lay off the distance *v-w* equal to the diameter of the pin used on the shuttle. The average value of this is ⅜ in. For wire larger than No. 9 use ½ in. and for No. 6 or larger, use ⅝ in. For high-voltage coils, use ¾ in. If a small pin is used for high-voltage coils, the insulation required around the coil ends will cause a bulge at this point and the coils will bind when being wound on the motor. After this distance is measured, connect *w* with *d*.

(10) Lay off *d-e* equal to *d-e* in I, Fig. 7. Draw *e-x* parallel to *d-w*.

After these lines are drawn, they show the coil as seen from the end of the stator. The next step is to draw the coil as it will look when viewed from on top of the face of the stator. For this purpose, pass to IV, Fig. 7.

(11) Draw the horizontal line (11).

(12) Draw horizontal line (12) at a distance *A* from line (11). For the values for *A* see the table II, Fig. 7.

(13) Draw line (13) at a distance *N* from line (12). For *N* see the diagram and the table in II, Fig. 7.

(14) Vertical line through *a*.

(15) Vertical line through *b* which is one slot distant from *a*.

(16) Vertical line through *b'* which is one slot distant from *a'*.

(17) Draw the arc (17) around the point *b* with a radius equal to the width of one coil, plus any air space required between coils. This air space will be from 1/16 in. to ¼ in., depending on the size of the motor.

(18) Draw the arc (18) around *b'*, using the same radius as for arc (17).

(19) Draw a line from *a* just touching the arc (17).

(20) Draw a line from *a'* just touching the arc (18). These last two lines will meet at a point *p*. This point will be on the center line of the pin. It will also be on the center line of the coil. As the two arcs just drawn will have very small radii, there is a chance that the lines will not be drawn in exactly the right direction. Therefore the position of these lines should be checked. If these lines do not make a wide enough angle with the base line, the end portions of the coil will be too crowded and may not fit into place. To check their position, proceed as in the following:

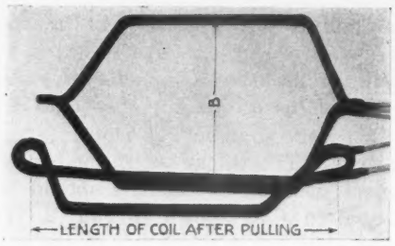


Fig. 6. Layer-wound coil after it has been pulled.

(21) Draw a vertical line through *p* which is *p-r*.

(22) From the point *s* draw the line (22) at right angles to the line *a-p*. Space on this line one-half the number of coil sides in the coil pitch. The dimension of the coil which will show on the drawing will be the coil width. In doing this, remember that the line *a-p* cuts the center of the first coil. If the coil pitch is even, the point *s* will be in the center of one of the coils as shown. If the coil pitch is odd, the point *s* will be in the center of one of the air spaces.

Fig. 7. Method of laying out a layer-wound pulled coil.

At I are shown the measurements which are taken from the core of the motor. In II is a coil in place in the slot. The successive steps taken in laying out a stator coil are shown in III and IV. The numbers in the circles indicate the order in which the lines are drawn. V shows how a rotor coil is laid out.

How to Take the Dimensions From the Diagram for Making the Shuttle for a Stator Coil

After these drawings have been made, the dimensions can be taken from them for making the shuttle for setting the pulling machine. Of course all of these drawings should be made to scale so that correct measurements can be made with a rule.

The length of the shuttle between the centers of pins equals $2(a\text{-}p)+$ (length of long cell) $+2(c\text{-}v\text{—}c\text{-}y)+$ (diameter of pin). Take *a-p* as in IV, Fig. 7. Take *c-v* and *c-y* as in III, Fig. 7.

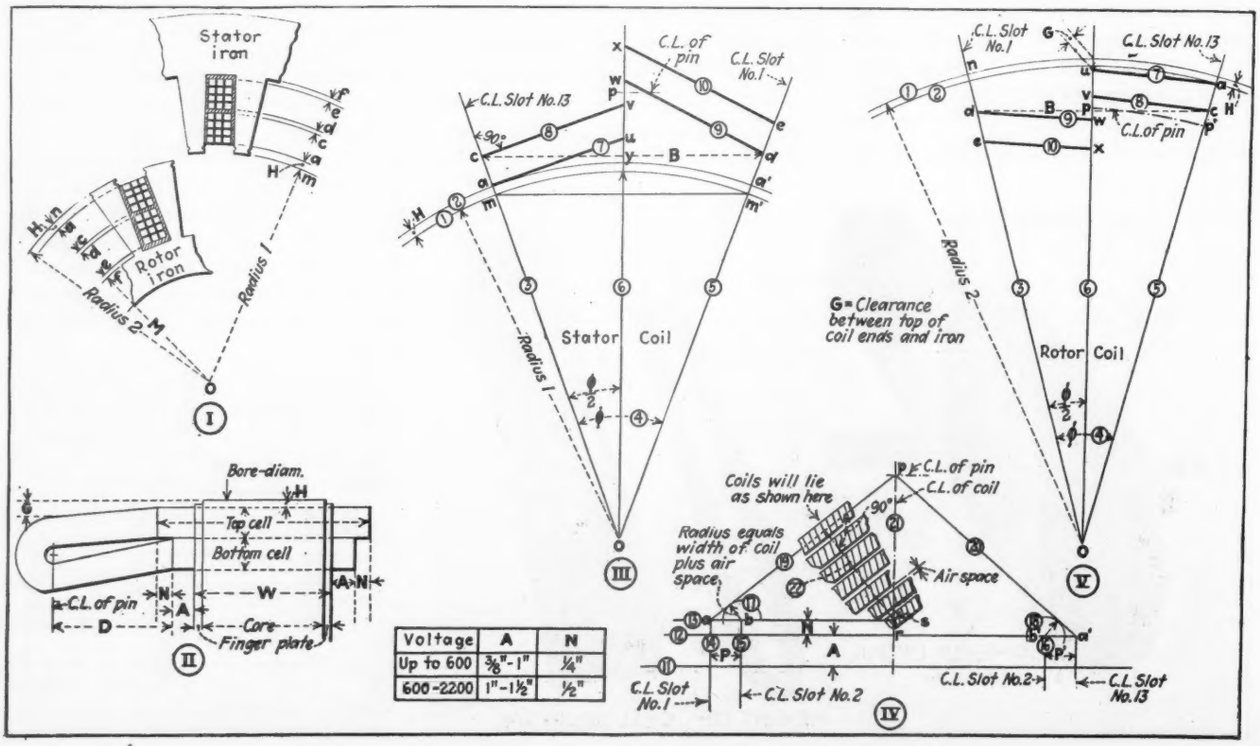
The radius of pulling equals *O-c* as in III, Fig. 7. The kick-up equals (*O-c*—*O-p*) as in III, Fig. 7.

The angle of pulling equals Ø as in III, Fig. 7.

The inside length of the coil after pulling equals $2(s\text{-}p)+$ (length of long cell) $+$ (diameter of pin). Take (*s-p*) as in IV, Fig. 7.

How to Lay Out Dimensions of Rotor Coils

To lay out the dimensions for a rotor coil, follow the drawing V, Fig. 7.



Voltage	A	N
Up to 600	⅜"-1"	¼"
600-2200	1"-1½"	½"

(1) Draw arc (1) with a radius equal to the radius of the rotor as shown in I, Fig. 7, Radius 2.

(2) Draw arc (2). The radius for this arc is less than that for arc (1) by the distance *H* at I, Fig. 7. This distance *H* is the distance of the top cell below the surface of the rotor iron.

(3) Draw line (3) as shown.

(4) Draw the angle Ø which equals (360 deg.÷no. of slots)×(coil pitch).

(5) Draw the line *o-a* making the angle Ø with the line (3).

(6) Draw the center line (6).

(7) Measure the distance *G* on line (6). This distance *G* is equal to the kick-down of the coil and should be never less than ⅛ in. and should preferably be ¼ in. This is the distance the coil will come below the surface of the rotor iron. When this distance is measured off, draw a line from *u* to *a*.

(8) Measure the distance *a-c* equal to the thickness of one coil without insulation. This is the same as *a-c* in I, Fig. 7. Draw a line from *c* to *v* parallel to line (7).

(9) Measure off the distance *v-w* equal to the diameter of the pin to be used on the shuttle. The average value of this pin should be ⅜ in. For wire larger than No. 9 use ½ in. For No. 6 or larger, use ⅝ in. For high-voltage coils, use ¾ in. After measuring off the distance *v-w*, measure off the distance *n-d*. This distance *n-d* equals the distance *n-d* as shown in I, Fig. 7. It is the distance from the top of the teeth to the top of the bottom coil. After marking the points *w* and *d*, connect them with a line (9).

(10) Draw a line (10) parallel to line (9) at a distance equal to the height of one coil or *d-e* in I, Fig. 7.

This gives the shape of the coil as viewed from the end of the rotor. Now it is necessary to lay off the dimensions as viewed from the top of the rotor. This is done as shown in IV, Fig. 7, in exactly the same manner as it is for a stator coil. The method is given in the foregoing paragraph under Nos. 11 to 22, inclusive.

Dimensions of Shuttle for Rotor Coils of Pulled Layer-Wound Type

The length of the shuttle between the centers of the pins equals 2(*a-p*)+(length of the long cell)+2(*c-v*—*c-p*)+(diameter of pin). Take *a-p* as in IV, Fig. 7. Take (*c-v*—*c-p*) as in V, Fig. 7.

The radius of pulling equals *O-c* as in V, Fig. 7.

The kick-down equals *c-p'* in V, Fig. 7, which is ⅛ to ¼ in.

The angle of pulling equals Ø as in V, Fig. 7.

After pulling one coil, it is well to check the inside length of the coil. This length after pulling equals 2(*s-p*)+(length of long cell)+(diameter of pin). Take (*s-p*) as in IV, Fig. 7.

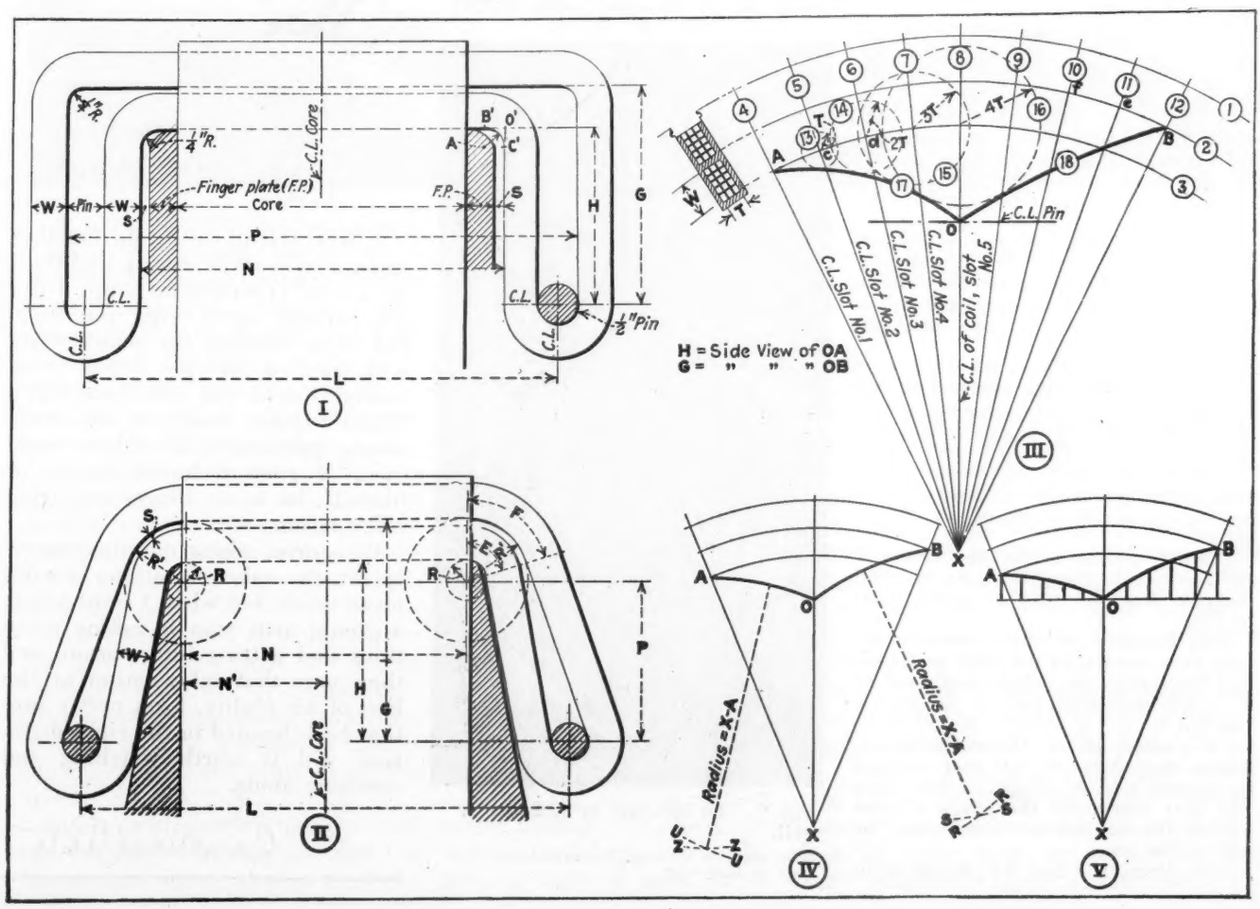
Development of an Involute Coil

The development and layout of an involute or Ackemeyer coil is done as shown in Fig. 9. Fig. 8 shows photographs of this type of coil. This coil can be used to great advantage where the end room parallel to the shaft of the motor is scant but where there is ample room radially. The formed coils can be used to replace some of the old hand-wound armatures at less expense than the hand windings.

At I, Fig. 9, is a coil for a machine having flat end plates. The distance *N* equals the length of the core plus the finger plates plus the insulation,

Fig. 9. An involute or Ackemeyer coil is laid out as shown here.

At I is a view of a rotor having straight end plates, while II shows a rotor with tapered end plates. III shows how to get the correct curves for making the mold. This is explained fully in the article. V shows how the curve may be laid off after its shape is obtained as in III. Vertical lines are drawn as shown equal distances apart. Then these distances are measured and the dimensions written on the drawing. By consulting the drawing these distances may be laid off on the material of which the mold is made. In this way the correct shape of the curves may be followed. Fig. 8 shows photographs of this type of coil.



S, on the end plates. The distance *P* equals *N*+2*W*+(2×diameter of the pin). In figuring this value, *W* equals the height of the coil as in I and III, Fig. 9. *L* is the distance between the center lines of the pins. *H* is the distance from the pin to the inside turn of the bottom half of the coil. It is equal to the line *O-A* (III, Fig. 9) when viewed from the side. *G* is the distance from the pin to the inside turn of the top half of the coil. It is a side view of *O-B* in III, Fig. 9. The dimensions are all for inside turns. These drawings, I, Fig. 9, and III, Fig. 9, give all the dimensions necessary for making the mold.

In case the end plates are tapered, the drawing in II, Fig. 9, must be used. *L* is the distance between the center lines of the pins. *N* is the distance between the centers of the radii *R-R*. *R* is made just long enough to allow the coil to hug the core and end plates. *R'* equals *R*+*W*+*S*, where *W* equals the coil height, and *S* the insulation thickness. The dimensions *N* and *P* are given to allow the carpenter to locate the centers of *R* and *R'*. The dimensions are all for inside turns.

In order to draw III, Fig. 9, proceed as follows:

(1) Draw the arc (1) with the radius of the rotor.

(2) Draw the arc (2) through the bottom of the top coil.

(3) Draw the arc (3) through the bottom of the bottom coil.

(4) Draw line (4) which represents the center line of slot No. 1.

(5) Draw the center line of the next slot No. 2.

(6) to (12) Draw the center lines of the following slots until the complete coil pitch is covered. In the drawing in III, Fig. 9, the pitch is 1 to 9 and therefore the center lines of nine slots are drawn.

(13) At the point *C* in III, Fig. 9, describe circle (13) using radius *T* which equals the thickness of the insulated coil. This point *c* is the intersection of the center line of slot (2) with the arc (3).

(14) At the point *d* describe circle (14) using 2 *T* as the radius. This *T* is equal to the thickness of the coil as before.

(15) Move over to the intersection of the next center line (slot No. 4) and describe arc (15) with a radius equal to 3 *T*.

(16) Continue in this manner stepping over one slot to the right each time and increasing the radius each time by *T*, until the center line of the coil is reached.

(17) After all of these circles are drawn, draw the line *A-O* just touching the bottom edge of all the circles. This line *A-O* represents the shape of one-half of the coil end as viewed from the end of the rotor.

(18) Draw the line *B-O* in the same way as *A-O* was drawn. The circles in this case are started first at the point *e*, then *f*, increasing the radius each time by a value equal to *T*. The distance *T* used must be the thickness of a completely insulated coil.

With this end view of the coil and the view shown at the left-hand side of Fig. 9, I or II, the mold may be made.

In drawing the line *A-O* a curved rule should be used in order to get a smooth curve. If desired, this curve *A-O* may be drawn with a compass as shown in IV, Fig. 9. After the curve *A-O* has been drawn in roughly so as to determine the point *O*, take a compass with radius equal to *X-A* and describe first the arc *V-V* as shown in IV, Fig. 9, using *A* as a center. Then describe the arc *U-U* with the same radius, using *O* as a center. The point where the lines *U-U* and *V-V* intersect is then taken as a new center. With this center, draw the arc *A-O*, using the same radius *X-A*.

In order to allow the carpenter who will make the mold to get the dimensions from this curve, it may be well to lay it off as shown in V, Fig. 9. A horizontal line is drawn through the point *O* and then this horizontal line is divided into equal spaces, say 1 in. apart, and perpendiculars are erected at each point. Then dimensions are marked on each one of these perpendicular lines. By looking at this, the carpenter can take measurements which he can transfer to the material from which he is making the mold. For motors with straight finger plates the length of the coils between centers of pins equals ½ *N*+½ *P*+*W*+*O-A*+*O-B*. Take *N*, *R* and *W* from I, Fig. 9. Take *O-A* and *O-B* from III, Fig. 9. For tapered finger plates, the length of the coil between centers of pins equals *N*+*E*+*F*+*O-A*+*O-B*. Take *N*, *E* and *F* from II, Fig. 9, and take *O-A* and *O-B* from III, Fig. 9.

All these methods are practicable and have been used by the writer for years with good success. They are not mathematically correct but they are near enough correct to serve practical purposes. In using these methods one practice coil only has been found necessary before a full set of working coils could be made from the drawings.

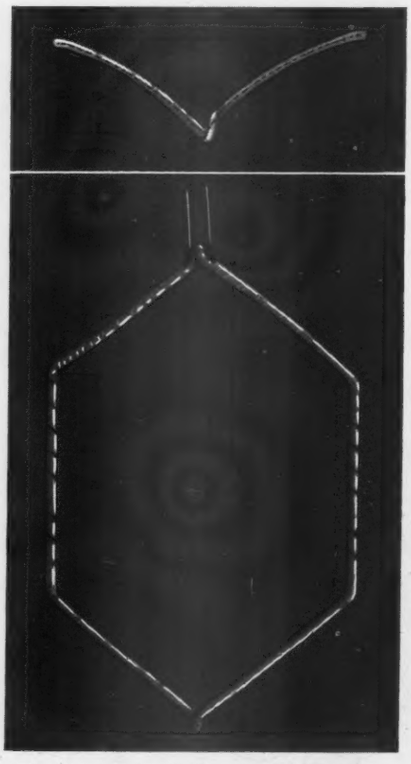


Fig. 8. An involute or Ackemeyer coil.

The details of Fig. 9 show how this coil is laid out.

Do You Ask Questions?

A wise friend once told me that when a man stops asking questions he is dead from the neck up. I did not entirely agree with him then, but after dealing for many years with men of all ages, I have concluded that he was just about right. When anyone, young or old, stops asking questions of his fellow workmen, of good technical books, of himself, he is no longer acquiring information.

Of course, asking questions merely for the sake of talking doesn't mean much, but when I come across a young man who is asking questions and getting information, and then uses that information to the best of his ability, I am pretty sure that he is headed in the right direction and is worth watching and coaching along.

Practical Pete

Fig. 1—Foundry of the Holt Manufacturing Company, Stockton, Cal., where 6.5 foot candles intensity is provided by 500-watt lamps in enameled deep bowl steel reflectors, spaced on 20-ft. centers, 35 feet above the floor.

An Analysis of the Elements of

Good Foundry Lighting

and Some Practical Maintenance Suggestions to Get the Most Out of It

By J. M. SHUTE

Electrical Department, Edison Lamp Works of General Electric Company

A NUMBER OF interesting problems present themselves in working out suitable lighting arrangements for foundries. Swirling dust-laden smoke and gases not only reduce the ability of the air to transmit light, but also coat all objects, including the reflecting equipment of the lighting system, with a light-absorbing film of dust. Thus the stream of light from its source to the object not only is impeded, but much of the original light is wasted through absorption by these dust-covered surfaces.

Although at first it might appear that almost any type of lighting equipment would satisfy foundry conditions, observations have shown that there are three governing factors which determine the lighting requirements.

First, as already stated, the dust and gas in the atmosphere and the film of dust which adheres to all objects make it necessary to use equipment which does not depend upon the walls and ceiling for reflection but directs its light toward the work.

Second, although the work appears to be of a rough nature, lack of proper illumination often results in rough and imperfect molds from which perfect castings cannot be obtained. A good lighting system is cheaper than imperfect castings which, even after patching or grinding, are weak. The light should be of a diffused character to penetrate the mold, but should be directional enough to bring out objects in their true shape. Too great diffusion will give such a flat illumination that the juncture of different planes may become distinguishable and thus cause serious errors in molding.

Third, and most important, is the safety element. The work carried on during the latter part of day when natural light is poor, is in itself dangerous. The air is heavy with dusty smoke and gases, and hurrying men carry molten metal from the furnaces to the molds. Here the lighting should be adequate to facilitate the hurried handling of this molten metal with perfect safety. Statistics show conclusively that the accident rate is high during the dark months of the year, and also that the rate is higher in poorly lighted plants than those well lighted. The lighting system thus becomes a form of insurance on the business and should not be neglected because of an erroneous belief in its unimportance.

There is frequent evidence of a feeling in industrial works that the expenditure for lighting must be kept at an absolute minimum and there is often provided only a low intensity of general illumination, supplemented by drop lamps or portables. This practice is rarely satisfactory. The

safety element is almost nil and the extension lamps are always a source of trouble. The cords wear out rapidly, are frequently in the way and are both electrical and stumbling hazards.

When a general system is provided the equipment can be selected to give the proper distribution of light and if the system is properly laid out an even intensity will prevail over the entire area lighted. By the use of a general system advantage is taken of the increased efficiency of larger lamps, there are fewer lighting units to get out of order and the maintenance cost is cut down. Such a system decreases the accident hazard as there can be no chance of the wires coming in contact with the work, nor are they within reach of the workman to be moved about to suit his individual whim or to be fallen over inadvertently.

Conditions Lighting Equipment Should Satisfy

A careful study of foundry conditions shows that equipment should be permanent, easy to clean, efficient and give a downward distribution.

To obtain permanency for such conditions the equipment must be of rugged construction, of such material that the action of gases will not rapidly depreciate its reflective powers and of such construction that the dust particles will not settle to a great extent on the reflecting surface. The equipment must be simple, and not made up of complicated parts requiring great care in assembling and cleaning. Units which can be wiped out with little trouble and a minimum expenditure of time result in a much lower maintenance cost.

Equipment which is highly efficient should be selected as the lighting requirements are such that high diffusion is not essential. Coatings of dust have less effect in decreasing the illumination if the initial efficiency is high, and the cost of equipment and power is much less if a relatively large quantity of the light given off can be utilized.

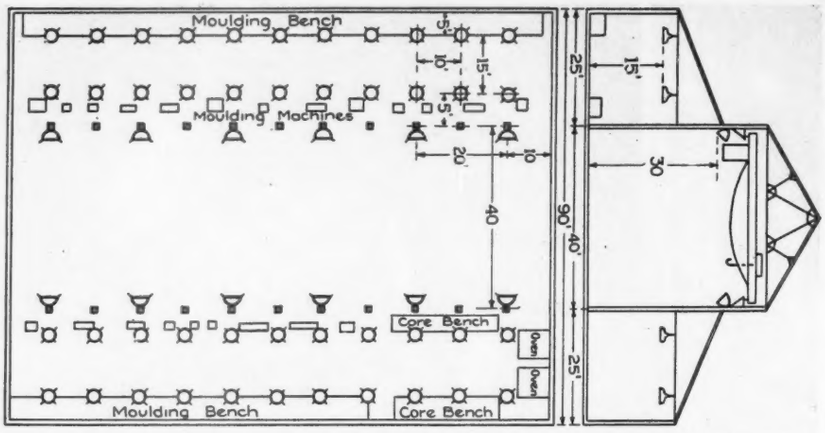


Fig. 2. Lighting layout for a three-section foundry.
The center section is lighted by twelve 300-watt clear Mazda C lamps in angle steel reflectors. The side sections use twenty-two 150-watt clear Mazda C lamps in R. L. M. dome reflectors.

Proper distribution of light must be possible from the equipment, otherwise its purpose is defeated. If the system is such that light is projected downward at a steep angle, the best results are obtained. A widely diffusing unit is most inefficient as too much of the flux impinges on the dark, dusty side walls.

These conditions can be satisfied by either an enameled steel bowl reflector or an "R. L. M. Standard Dome" reflector equipped with a Mazda C lamp. At first thought one might assume that the deep bowl reflector with its narrow distribution of light would be preferable, yet if one examines the distribution curves carefully it will be seen that the "R. L. M. Standard Dome" gives almost as much light in the angle over which the bowl spreads and in

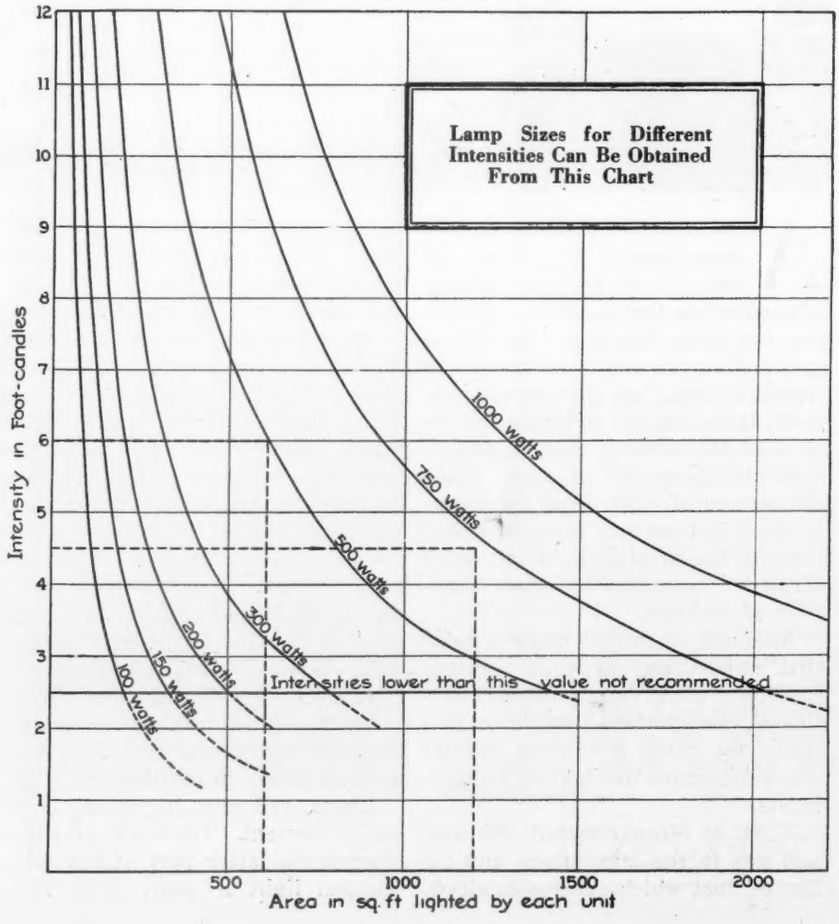


Fig. 3. Chart for determining size of lamp for a desired intensity of lighting.
This chart is based on a 0.40 coefficient of utilization. In using the chart proceed as follows: Locate on the vertical scale the intensity in foot candles desired and draw a line horizontally across the chart. Then locate on the horizontal scale the square feet of area to be lighted by each unit and draw a vertical line on the chart. The point where these two lines intersect gives the value in watts from which the size of lamps should be selected. In case the intersecting point is between two curves bearing lamp sizes in watts, the higher value should be used.

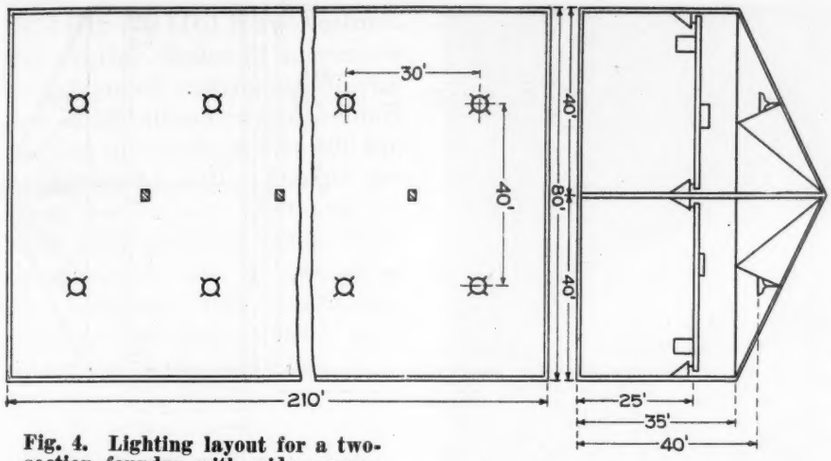


Fig. 4. Lighting layout for a two-section foundry with wide separation of lamps.

The lighting equipment consists of fourteen 750-watt clear Mazda C lamps in R. L. M. dome reflectors spaced 40 ft. one way and 30 ft. the other.

addition more illumination at wider angles and so makes a considerable gain without any appreciable sacrifice.

Elimination of Glare

A feature of illumination affecting the problem of foundry lighting is glare. A light source from which the rays are directed into the eyes causing annoyance and discomfort is said to be glaring. A glaring light not only reduces the effectiveness and usefulness of illumination, but is harmful to the eyes. Glare may be present under widely different circumstances. A large lamp high above the observer projecting its light steeply downward is not likely to produce glare, while a much smaller lamp in the range of vision can be very glaring. Again a lamp in a room finished in a light color might not be in the least glaring while the same lamp in dark surroundings may be mounted so that it is very harmful.

There is no set rule which can be followed to get the necessary diffusion to prevent glare. Each installation must be considered separately. However, in foundries there is little chance of reflection due to the absence of polished objects. In general it will be safe to say that clear lamps may be used in foundries where they are to be mounted 15 ft. or more above the floor. For mounting heights less than 15 ft. some form of diffusing medium should cover the bowl of the lamp to prevent any possibility of glare.

It has been found that the best practical diffusing medium is the bowl enameling which is furnished on Mazda C lamps when requested. This enameling is sprayed onto the lamp and automatically becomes baked on when the lamp is lighted and heated.

It is efficient and durable and gives good diffusion. After the lamp has been burned for a few hours, the enamel will not wash off and can be readily cleaned. Cleaning brings it back much nearer to original efficiency than in the case of bowl frosting. Another advantage over frosting is that, due to its density and the fact that it is a spray and not an etch, much more light can be reflected from its inner side than can be reflected from frosting when in an equally dirty condition. Bowl enameled lamps are therefore desirable for those cases where there is a low hanging height.

Special Foundry Requirements

No definite rule to determine the exact amount of light required can be given. The workman wants as much as he can get, and the owner wants to hold the expense down as far as compatible with good efficiency in his workmen. In each particular case it must be a question of judgment on the part of the owner and his engineer, after study and inspection of operating conditions.

1. *Floor Molding and Pouring.*—The lighting for floor molding and pouring will naturally be the same since this work is carried on at different times of the day in the same area. The molding is done in the early hours of the day and is the work calling for the most accuracy. Usually at this time the natural light is at its best, for the air is free of dust-laden gases; however, in many plants the work starts before daylight, especially during the winter, and an artificial lighting system is called upon. If the lighting system is such that light is projected downward at a steep angle, the best penetration of molds will be obtained. For molding and casting the intensity should be from 4 to 12 foot-candles, depending upon the nature of the work. Somewhere between these two limits is the proper amount for each particular case, depending upon the character of the work. For foundries turning out large heavy castings where finish of the mold is not important, intensities of from 4 to 6 foot-candles are sufficient. However, in foundries casting small objects requiring careful finish and

Fig. 5. View at night in a foundry with the lighting layout as shown in Fig. 4.

Even illumination throughout together with the clearness of details illustrates the benefits of proper care in installing a lighting system. The intensity here is 4.5 foot-candles.

much sharpness of detail, intensities of from 6 to 12 foot-candles will be none too much. An installation of 6.5 foot-candles is shown in Fig. 1.

For pouring and stripping the molds the lighting requirements are less exacting, yet suitable lighting is important from the standpoint of safety. This operation is carried on during the latter part of the day when the natural light is poor. The air is full of flying dust and gases and less of the initial light reaches the work. In general if the lighting requirements for molding are followed, a lower yet adequate intensity for pouring will prevail.

2. *Bench Molding, Machine Molding, and Core Making.*—Lighting for this type of work, which calls for some distinctness of detail since the pieces turned out are usually small and must be accurately molded, can best be accomplished by what is termed a "localized general" system. A high intensity is required along the row of machines or benches while a lower illumination is sufficient for the remainder of the room. This effect of varied intensity is obtained by placing the lighting units relative to the machines. The maximum intensity is thus delivered from the correct direction and the spread of light takes care of the surrounding areas. Such a system has practically all the advantages of the drop light in getting the light where it is needed and yet the lighting units are not within reach. An example of such lighting is shown in the side bays in Fig. 2.

3. *Charging, Tumbling and Cleaning.* For the charging space and rooms used for tumbling and cleaning, intensities of from 3 to 6 foot-candles are adequate. Here the work is of the roughest nature and very little distinctness of detail is necessary, so that a general system giving this low intensity will allow the work to be carried on with perfect safety. The points to bear in mind in lighting such work are to mount the units in the best positions and to furnish the lamps with the proper reflecting equipment for those positions.

Care should always be taken that all stairways and ladders are properly illuminated by lighting units so equipped with reflectors that there is never a chance of the men being blinded by the glare from a bright light source. The charging floor, particularly near the furnace doors, should be properly lighted so that the work may be carried on speedily and efficiently with no chance of accidents due to glaring or inadequate illumination. Hatchways and pits should also be illuminated in such a manner that they can be seen clearly at all times, thus eliminating the possibilities of dangerous falls and injuries.

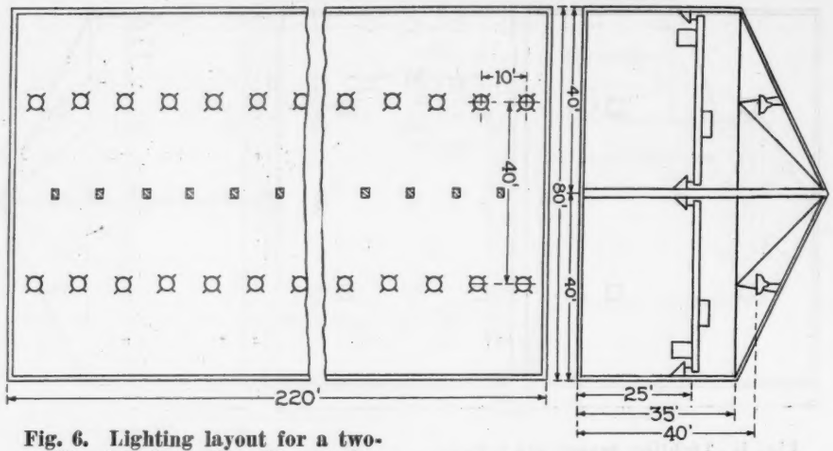


Fig. 6. Lighting layout for a two-section foundry with wide spacing one way and close spacing the other.
The lighting units consist of forty-four 300-watt clear Mazda C lamps in R. L. M. standard dome reflectors.

Application of These Principles to Specific Cases

After the type of equipment is decided upon, the size and arrangement of the lighting units must be considered. Here the size and shape of the foundry and size and quality of castings will be the deciding factors in selecting and arranging the lighting equipment. As stated above, a system providing general illumination will be best in almost every case for foundry lighting.

The area of the foundry and the possible mounting height of lighting units will determine the number and arrangement of them. A few large units are least expensive, but the use of too few produces uneven and unsatisfactory illumination. In deciding upon the number, *the best rule to follow is to space the units not much farther apart than the possible mounting height above the floor.* Such a spacing will insure an even distribution of light and the size of unit used will determine the intensity of this light. If a wide spacing and high hanging height is used each unit must obviously be of a larger size than if closer spacing is used, since the light must be distributed over a larger area. Also the desired intensity depending upon the work done will decide the size of unit. (*Continued on page* 205.)

Fig. 7. Night view in a foundry with the lighting layout shown in Fig. 6.
Absence of shadows due to close spacing of adjacent lighting units is noticeable and the clearness of all details can be attributed to the even illumination of 5 foot-candles.

IN THIS ARTICLE are outlined the routine duties of inspectors to safeguard continuous operation of 235 direct-current motors ranging in size from 5 to 300 hp. in a cement mill. Details are given for certain tests and repairs that must be made while these motors are in operation. To maintain this continuous service, eight inspections of each motor are made every day.

Attention That Is Required

When Motors Must Operate 24 Hours a Day

the Year Around in a Cement Mill

Sanding the commutator of a 250-hp. mill motor.
This machine was flashing badly at the brushes, but was returned to normal operating condition by the use of a piece of sandpaper on the commutator. Each inspector carries a small piece of sandstone about two inches square by one-half an inch thick with which he cleans off the commutators of small motors when they are found to be dirty. The plate over the end of the bearing is made tight to keep out cement dust. All motors are cleaned with an air blast about once a month. Air at about 80-lbs. pressure is used with a ¾-in. pipe tipped with a piece of loom extending an inch or two beyond the end of the pipe as a nozzle. Motors are not wiped with waste.

IN A CEMENT MILL the accumulation of dust on electrical equipment calls for a thorough inspection and maintenance schedule. Details are given in this article of the inspection practice followed in a large middle-west cement mill where 235 motors are operated continuously 24 hours a day, including Sundays and holidays. Constant attention to the operating condition of motors is the key to this continuous service. No such practice as a weekly inspection or even a daily inspection suffices. The maintenance schedule calls for eight inspections of every motor in the plant every day in the year.

The 235 motors installed range in size from 5 hp. up to 300 hp., the average being approximately 65 hp. Energy is supplied to the entire plant by a 250-volt direct-current generating plant located on the property. Feeders run from the main bus to five distribution switchboards located at central points. From these switchboards direct lines are run to each separate motor, except in a few special cases. These special instances are where more than one motor is supplied from a line, as in the case of two or more motors driving associated equipments, such as a grinder and its feeding conveyor. When the grinder shuts down it is essential that the feed stop at the same time, and by having the two motors on one line this situation is automatically taken care of in case of line trouble, the blowing of a fuse at the switchboard, or similar accidents. For general protection, circuit breakers set for 30 per cent over normal load are installed on all main switchboard panels feeding the distribution boards. Fuses for each circuit are mounted on the back of the distribution boards, and a second set of fuses is installed with the knife switch at each motor location. Motors of 10 to 15-hp. rating are protected with wire fuses of 60-ampere capacity, two loops of 30-ampere wire being used. The 250-hp. motors are protected by two 450-ampere Economy renewable cartridge fuses in parallel. Motors of intermediate sizes are fused in similar proportion; that is, with only a slight margin above the ratings of the motors.

THREE INSPECTORS WORK ON SHIFTS OF 8 HOURS EACH

As has already been stated, the key to continuous operation is constant attention. In order to assure regular attention to each unit, three men in the electrical department are assigned to specific inspection duties, each man having an eight-hour shift so that an inspector is on duty at all times.

The first shift extends from 7:30 a. m. to 3:30 p. m., the second shift from 3:30 p. m. to 11:30 p. m, and the third shift from 11:30 p. m. to 7:30 a. m. Each shift has certain duties to perform, the object being to have each man know his work and be responsible for it. The man on the first shift is required to inspect every motor in the plant twice during his time on duty. These inspections include feeling the bearings for heating, looking at the commutators and brushes, inspecting starting boxes, switches and fuses, and on one trip the checking of the air gap. Air gap tests are made between 9:30 a. m. and noon, so that the working force on duty during the daytime can make bearing or armature changes when they are required. The first shift inspector also changes short or damaged brushes.

Tests of air gap and changes of brushes are taken care of with the equipment in operation. In testing air gaps of the smaller machines a strip of ordinary red fiber 1/32 in. thick by 1 in. wide and about 15 in. long and a similar piece of fish paper 0.014 in. thick are used. In making the test the piece of fiber is held lightly in one hand and is slipped into the gap between the armature and the face of one of the field poles. The fiber is drawn across the face of the pole in the direction of the armature rotation, coming out unmarked if the air gap still remains

High Spots in Motor Service and Its Maintenance

[1]
235 motors are operated 24 hours a day the year around.

[2]
These motors are inspected eight times each day by three inspectors working on eight-hour shifts.

[3]
Air gaps are tested and brushes are replaced while motors are in operation.

[4]
An average of 40 new brushes are replaced per day.

[5]
Motors in severe service wear out bearings in two weeks.

[6]
Electrical maintenance work is handled by a chief electrician, three inspectors and a maintenance crew of an assistant chief and four men.

Examining the motor driving a cement kiln (upper illustration). The inspector is shown here feeling the bearing for temperature and at the same time looking through the upper left-hand air gap. Both the commutator and brushes are inspected from this end. The motor has a ball bearing on the pulley side that must be judged by sound as well as by temperature. This and other motors on similar service are worked at about half their rated capacity but have exceptional bearing life of from one to approximately two years.

Examining brushes for cause of poor operation (right-hand illustration). Except in rare cases, all brush changes are made with the motor in operation. New brushes are inserted with flat ends as received from the manufacturer and are allowed to wear to shape. Extreme care is required in changing brushes to avoid making contact between the brush and its pigtail and other parts of the machine. If a brush were allowed to fall on the commutator while its pigtail was still fastened to the brush holder, the workman might be badly burned.

THREE EXAMINATIONS FREQUENTLY MADE

Testing the air gap while the motor is in operation (left-hand illustration). A strip of red fiber 1/32 in. thick by 1 in. wide and about 15 in. long is used to test the air gaps of direct-current motors while in operation. The strip is passed between the armature and pole piece in the direction of rotation. If the fiber is scored badly a piece of 0.014-in. fish paper is passed through the gap in the same manner. If the fish paper is cut the bearings are changed. The gap being tested usually wears short on the pulley and belted side.

Changing contacts on a control rheostat while the motor is in operation.

When contact segments become worn they have to be replaced, and in most cases the motor cannot be shut down, even for a short time, without great inconvenience. The workman has just removed the fourth and fifth contact plates from the left-hand side of the segment arc. It will be noted that the control handle is moved well to the right to be free from accidental contact with a partly loosened plate and to be out of the way. Screws to hold the plates are loosened with a screwdriver held in the right hand while the screws and plate are actually removed with the left hand. The plate is just being laid on the top of the box after being removed.

Examining upper bearing and commutator of a vertical motor.

These upper bearings are of the ball type and carry the weight of the armature and pulley. The housings are touched to detect heating. The inspector also listens for false sounds that would indicate lack of oil or a broken ball.

sufficiently large. If the fiber is scored in this test, a second trial is made using the fish paper. When the bearings have worn down until the fish paper is badly scored on passage through the gap, new bearings are put on the motor. Incidentally, the air gaps on the motors tested in this manner are approximately 1/16 in. when in normal condition.

Air gaps on the large 250-hp. motors are 3/16 in. when in good condition. These gaps are tested by inspection, the inspector looking through the space between the armature and poles in order to judge the condition of the bearings. This, of course, does not give so close an indication of condition as the fiber and paper test, but the original gaps are much larger in this case and the importance of the larger device does not permit going nearly so close to complete wearing of the bearings.

Replacement of brushes with the motor in operation calls for careful work to insure safety to both the operator and the machine. Canvas gloves are used in this operation, one hand being used to lift the spring on the brush holder while the other is used to grip the brush firmly and pull it out. It is held in the hand after removal. Then with the brush held well in the clear, the pigtail is loosened from the brushholder by the hand used to raise the spring. A new brush is inserted in a similar manner but with the operations reversed. It is essential that the brush and its pigtail be kept free from all parts of the machine except those parts where they make contact normally, and it is best always to disconnect the pigtail last on removals and connect it first on replacements. New brushes are put in service with flat ends as received from the manufacturer and are allowed to wear to shape, except in cases where a large area of brush surface on a machine is changed at one time. In such cases the motor is shut down long enough to grind in the brushes in the ordinary way with a strip of sandpaper between the commutator and the faces of the brushes. A total of about 40 new brushes per day are required, only about 2 per cent of them being sanded to fit the commutators.

Duties of Inspector on Second Shift

Duties assigned to the inspector on the second shift include three complete rounds of the plant every day and the oiling of all motors. The bearings are felt for heating and the commutators, switches, fuses and starting boxes are inspected on each round. A heavy paint brush 4 in. wide by 2 in. thick is used to dust off the housings before lifting the caps to the oil wells. This is done every night and comprises the only frequent regular cleaning given to any part of the motor equipment. The average nightly oiling requires 3 gals. of Griffin oil and 1 gal. Red engine oil. (*Continued on page* 206.)

THE MARKED SUCCESS with which electric arc welding has been used on the Rock Island lines can be ascribed to a thorough study of methods of procedure in performing the work, the training and supervising of operators and the confidence and persistence with which Mr. Wanamaker has attacked the problem of making the electric welding machine a practical tool in the hands of a skilled workman. The policy of selecting only skilled tradesmen to be trained as welding operators has removed at the start much of the uncertainty which the human factor always introduces.

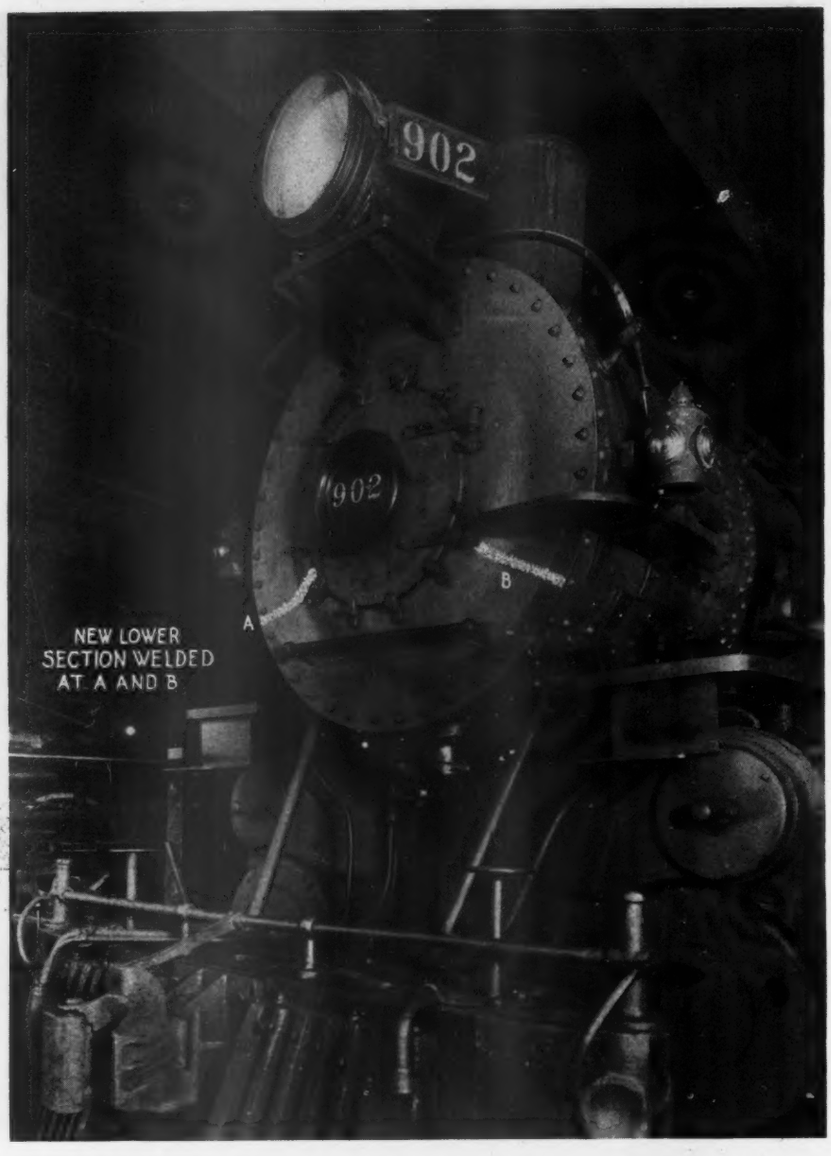
Some of the Reasons for the

Success of Electric Welding

in the Shops of the Rock Island Lines

By E. WANAMAKER

Electrical Engineer, Chicago, Rock Island & Pacific Railroad



IN keeping the rolling stock and other equipment of a great railroad system in working condition, general maintenance and repair work is an important operating item. Some ten years ago the writer was instructed to take up electric arc welding in the hope that considerable saving in time, labor and new parts could be effected by providing facilities for using the electric arc welding process in the many varieties of work where a weld could be applied on a repair job. This experience has lead to an investment of $150,000 in arc welding machines on which a return of about 300 per cent has been shown per year through making it possible to repair parts that would otherwise be replaced by new ones and by savings in time, labor and material over other methods.

The production of uniformly good welds on the variety of work encountered calls for skilled supervision as well as thorough training of the operators. These conditions have been met by appointing a "Supervisor of Welding and Electrical Equipment" who, with his two assistants, has general oversight of all welding, including the methods of procedure, the training of the operators and instructing of the foremen. The latter, of course, are in immediate charge of the operators.

It has been found that it is very helpful, even essential, for a welder to have had considerable experience in some mechanical trade. Consequently operators are selected for training from the ranks of the boilermakers, machinists, blacksmiths and so on. Such workmen not only have a background of experience, which is very useful, but a sense of craftsmanship as well, which is felt to be of decided value. No attempt is made to train novices or "handy men" as welders.

In order to standardize so far as possible the method of making welds for the repair of broken equipment or the using of the arc for building up worn parts, welding specifications and an instruction book have been prepared for the use of the operators and foremen. This book is very complete and in addition to a detailed discussion of arc welding and of the methods to be followed in making the welds encountered in railroad work, it contains practical diagrams which show very clearly the proper manner of preparing the parts, by V-ing out, studding, reinforcing with metal bars or strips and so on, before welding. The production of welds made in accordance with what has been found to be the best practice is thus assured. These instructions also serve as a very valuable

textbook in training the apprentice welder, for by carefully studying these instructions he is enabled to obtain a good understanding of the principles and methods involved in a much shorter time than would otherwise be possible.

Careful Preparation of Work Precedes Welding

When a broken part is assigned to a workman for repair, it is carefully prepared before the welding operation is started. The removal of grease, rust and foreign matter is accomplished by dipping in a caustic solution, sandblasting or by other appropriate means. The edges of the break are then beveled to a V-shape by a gas cutting torch or cold chisel in order that there may be room to build up the deposited metal from the bottom and secure a thorough union between the metal of the broken part and that furnished by the electrode. With cast iron parts numerous small holes are sometimes drilled around the break and tapped for the insertion of studs, which serve to give greater strength to the weld.

When the work is properly prepared it is usually connected to the positive lead of the electric welder by a suitable connector, the electrode which is held in an insulated clamp being the negative pole. This method of connection is followed for the reason that the larger portion, upward of 75 per cent, of the total heat of the arc is liberated at the positive pole. Since the metal of the piece has more mass and conducts the heat away from the point at which the welding is being done more rapidly than the electrode, making the work the positive pole concentrates more of the heat at the point where it is most needed. When using certain electrodes, high-manganese, high-carbon or slag-coated, it is necessary, however, to make these the positive pole, in order to heat the deposit sufficiently to secure good penetration and a uniform flow of the metal.

When making the weld the operator strikes an arc by touching the electrode for an instant to the part to be repaired and immediately withdrawing it a short distance, not more than ⅛ inch. The intense heat developed instantly melts the end of the electrode and the area of the broken part touched by the arc. By proper manipulation or "weaving" of the electrode the deposited metal is thoroughly incorporated with that derived from the work.

Some of the Savings Which Arc Welding Has Effected

Part Repaired	Cost of Old Method	Cost of Arc Welding	Saving
Eccentric straps	$ 8.97	$ 1.19	$ 7.78
Cross head	27.41	2.90	24.51
Piston head	11.98	2.56	9.42
Frame braces	9.95	1.50	8.45
Truck frame	5.23	1.35	3.88
Extension piston cross head	6.30	1.36	4.94
Air pump valves	2.50	.53	1.97
Drill chuck	15.00	.68	14.32
Wheel spokes	85.12	2.34	82.78
Triple valve gage	20.00	1.02	18.98
Link blocks	3.61	.77	2.84
Lift shafts	23.98	1.02	22.96
Chafing castings	8.30	3.20	5.10
Smoke box	61.38	4.96	56.42
Strip on cross heads	8.44	4.22	4.22
Boiler casings	63.21	9.32	53.89
Frame buckle	4.90	.91	3.99
Trailer yokes	5.25	1.95	3.30
Center castings	25.60	3.02	22.58
Building up side rods	46.74	15.58	31.16
Stationary fire door	8.00	2.72	5.28
Cracks in tanks	26.62	2.51	24.11
Pedestals	129.00	9.05	119.95
Tank frames	9.03	1.36	7.67
Piston rods	7.84	1.62	6.22
Sharp flange drivers	55.13	6.76	48.37
Truck side	48.50	2.55	45.95
Building up driving axles	121.50	4.90	116.60
Steel car under frame	11.34	1.71	9.63
Welding flues	25.56	5.11	20.45
Welding frames	84.64	12.12	72.52
Cracks in fire boxes	26.42	3.23	23.19

The operator is shown here welding the ventilator frame for a passenger car.

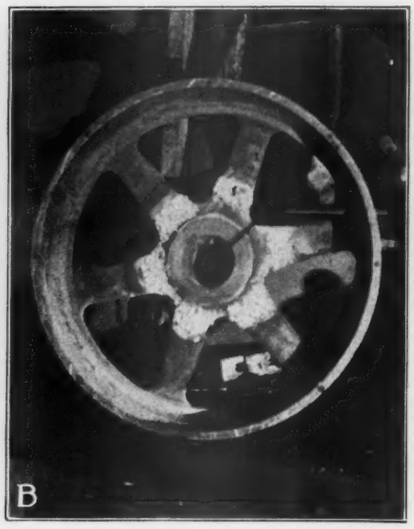
Finished Welds Are Inspected to Determine the Quality of the Workmanship

After a weld is completed it is inspected to determine whether it is of satisfactory quality. The factors which are mainly responsible for, or contributory to, unsound arc welds are poor fusion, slag inclusions and porosity of the deposit. A visual examination of the weld surface is made to determine (1) the general workmanship; (2) the uniformity of the deposit, as an indication of the skill with which the fused-in metal is put down; (3) the presence of slag and porosity of the metal as shown by the appearance of the surface and the uniformity of fusion between deposits at the points where the weld is made.

The base of the deposit may be chipped with a cold chisel to determine the adhesion of the deposit and the ductility of the fused-in metal. If the chipping breaks short like a poor grade of cast iron, it is a fair indication that the metal is burned, oxidized, due to excessive heat or excessive arc length. Welds composed of such metal will break comparatively easily when subjected to transverse stresses. When it is considered necessary, a so-called penetration test may be applied to detect linked gas pockets, slag pockets, porosity and unfused zones. While there are a number of possible methods that may be used to detect such weld imperfections, the penetration test offers the most reliable indication of unsoundness extending through the weld section, although isolated unfused zones, globule inclusions, gas pockets and the like will not be shown by this test.

Kerosene is usually employed for this purpose inasmuch as it works satisfactorily and is easy to obtain. When it is sprayed on one side of a welded joint, which is porous or contains a chain of unfused zones, slag pockets, gas pockets, or similar defects, it will be drawn into the capillaries produced by these imperfections. If they extend through the section, a stain will appear on the reverse side of the joint. This method is found particularly convenient and

A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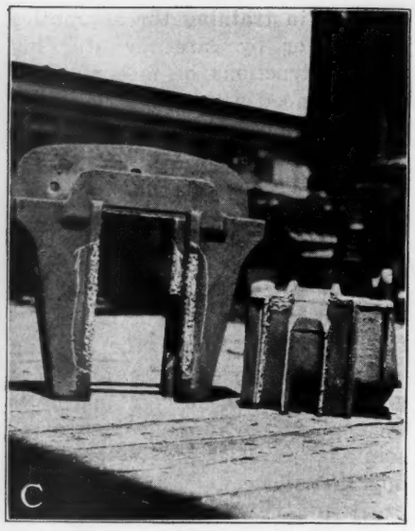

C

D

A few of the

Arc Welding Jobs

Done in the Rock Island Shops

A—The hard service to which a coupler is subjected constitutes a very severe test of the strength of a weld on these parts. Properly made welds stand such tests.

B—When the hub was broken out of this band wheel it went to the welder's bench, not to the junk pile, as would have been the case a few years ago.

C—Pedestal jaws and journal boxes of cars when they become worn are built up again with the electric arc as shown here.

E

D—This coupler was restored to service by welding in a new piece of metal to replace that which had been worn away.

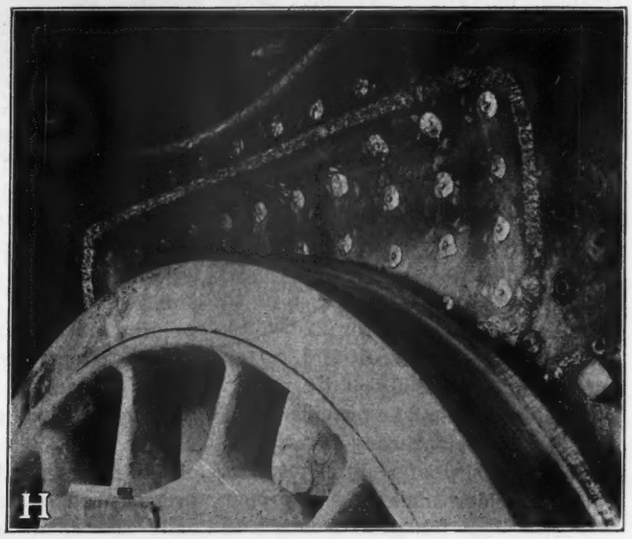
E—Heavy parts are placed on a low bench for welding. The operator is building up the worn equalizer bar of a locomotive.

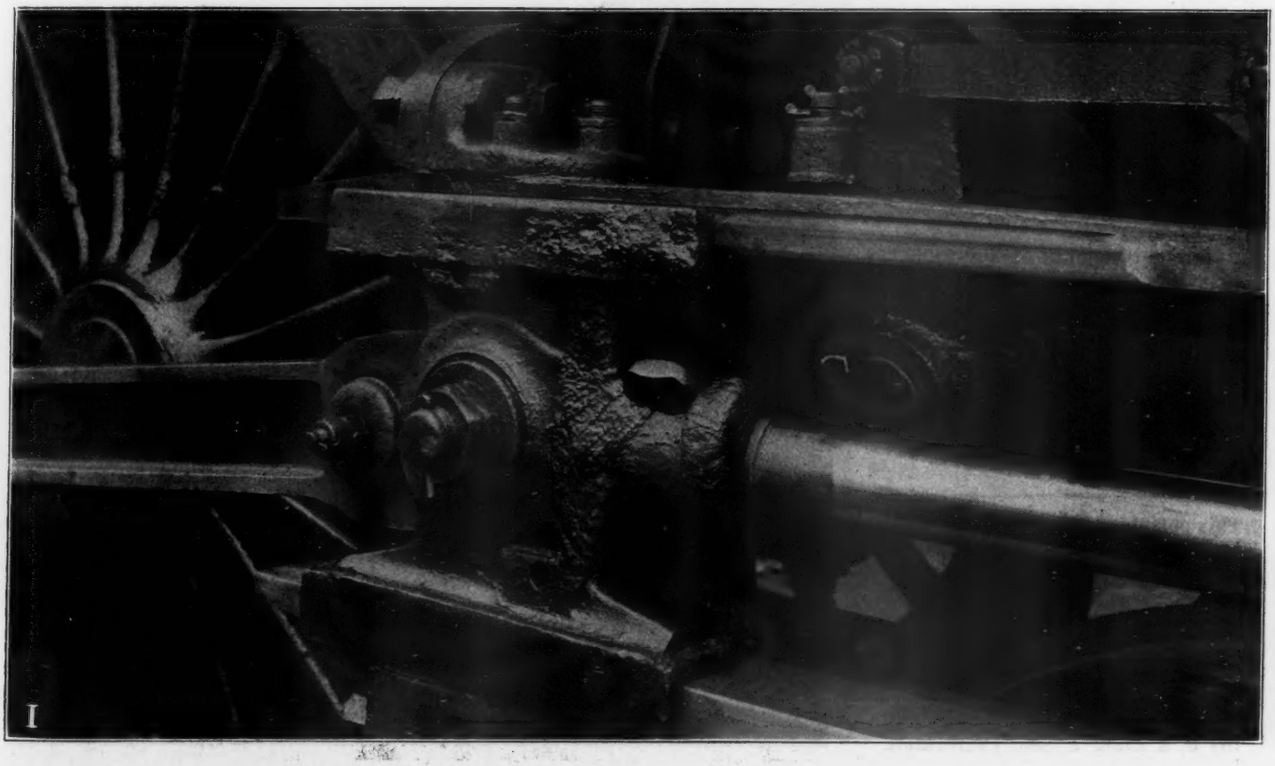
F—A good arc welding job has cured the leakage of steam from these front flue joints.

G—The head and part of the cylinder wall of this locomotive were broken off in an accident. The arc welder put them on again.

H—Welding in a patch was the simplest way of repairing this side sheet which had been worn down by the driving wheel.

I—Four driving wheel spokes and the crosshead of this locomotive have been repaired by welding.





effective in determining whether or not a joint is leak proof to water, air, steam, oil and so on.

Welding Equipment Is Purchased Under Specifications

A welding unit of 200-ampere capacity for continuous welding, which will permit the use of approximately 225 amperes for intermittent work or 250 amperes for short periods, has been found to be best suited for the work ordinarily encountered in the Rock Island repair shops. This equipment is purchased under the following specification:

"A portable electric metallic arc welding equipment of 200-ampere capacity for continuous welding duty (manual operation), 65-volt maximum open circuit voltage, complete with control panel and motor starter. Welder set to be equipped with radial ball bearings. Truck to be equipped with ball or roller bearings. Cleat for 150 ft. of No. 2 cable, sheet metal cover with side and end curtains, to make entirely weatherproof. To operate on 3-phase, 60-cycle, 440-volt, a. c. circuit.

"Motor to be constructed so as to be easily reconnected for 220 volts. In case the power circuit is d. c., the motor should be a 250-volt d. c. motor.

"The welder shall be provided with suitable means for conveniently reversing polarity of welding circuit. The arc welder shall possess proper characteristics for good welding in all positions for arc current values from 50 to 200 amperes, as demonstrated by experienced operators, without causing undue fatigue on the part of the operator.

"Suitable means shall be provided for adjustment of current from 50 to 200 amperes, in steps of not more than 5 amperes."

A few equipments of 300 amperes normal capacity, allowing the use of 400 amperes for short periods, are used for welding very heavy sections with coated electrodes. These outfits are purchased under specifications identical with that given above, except for the larger rating.

An engine-driven portable welding equipment.
A high-grade gasoline engine furnishes the power for driving the generator of this unit, which is used where no power circuits are available. It is manufactured by the U. S. Light and Heat Corporation.

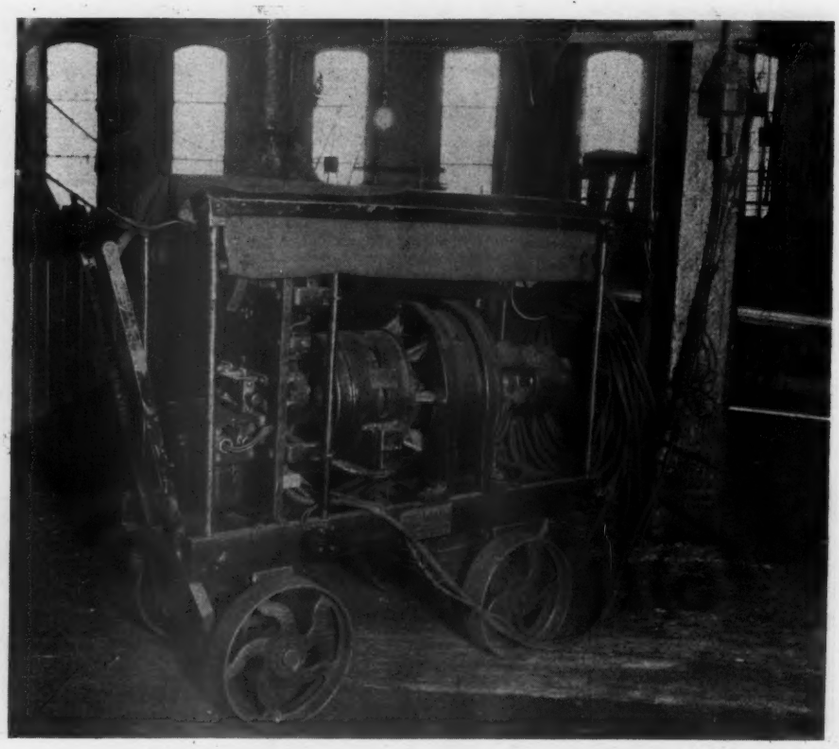
Power circuits for welding service are carried in conduit throughout the repair shops and round houses with numerous outlets provided with Ralco power receptacles placed on the columns or walls of the buildings. A welding outfit can thus be quickly placed in operation at any desired point. Inasmuch as there are only two standard voltages, 440-volt alternating and 250-volt direct current, on the Rock Island lines and a standard method of installation, practically the entire equipment can be used as a "flying squadron." When the work decreases at one point and increases at another, a unit is loaded into a box car or, if necessary, a baggage car and sent wherever it is needed.

In addition to the use of welding units in the repair shops and round houses, cars for track and structural welding have been planned. Living quarters are provided in one end of a good box car for a welding crew of two men, for a single-unit car, and three men for a double-unit car. The other end of the car has large end doors and portable runways are used for loading and unloading the welding equipment.

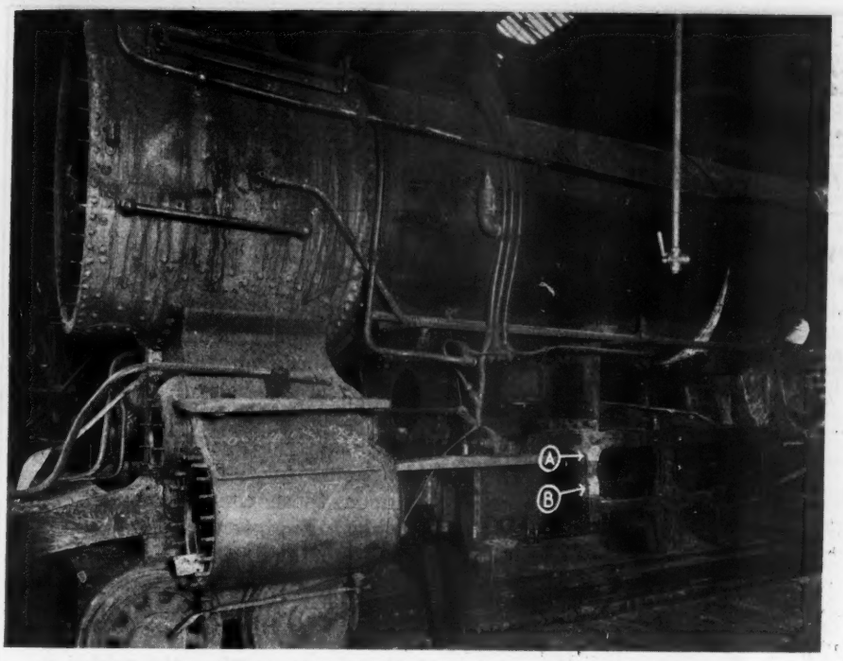
These units are weatherproof and are built to the same specifications as the generators for the standard welders. They are driven by high-grade gas engines having a smooth power-impulse. When in use the generator and engine, mounted on skids, are placed on well-built push cars which may be moved from place to place by hand, or trailed behind a section motor car.

Coated Electrodes Are Used for All Welding

The character of the metal from which the weld is made is a most important factor in determining the quality of the weld. The greatest defect of gas or arc-fused metal is its low resistance to torsional, transverse and fatigue stresses, and much



This portable electric welding outfit has paid for itself many times over.
A large number of these outfits is used in the repair shops. This machine is of 200-ampere capacity and can easily be moved to any desired point. Connection is made to the 440-volt, 60-cycle power circuit by the Ralco power receptacle and plug shown on the column. The frame of the welding unit is grounded to the conduit immediately above the receptacle. It is manufactured by the U. S. Light & Heat Corporation.



Here is a unique welding job—a locomotive frame welded in two places.

of the development work which has been done has been directed toward affording better protection to the molten metal from the air. The metal passing from the end of the electrode into the weld is heated to an extremely high temperature, a considerable portion of it is even in a gaseous state, and it is, therefore, very easily affected by the gases composing the air even though the journey through the atmosphere is a short one. By the use of electrodes which are coated with some material which will melt and form a protecting film over the molten metal at the weld the possibility of damage from oxidation or other atmospheric effects is greatly reduced.

On the Rock Island lines it has recently been decided to use coated electrodes exclusively. Experience has demonstrated that in so far as arc welding is concerned the best is none too good. What are known as Wanamaker coated electrodes are used for all arc welding at the present time. These are supplied by the Transportation Engineering Corporation and are of five different types or grades, which are distinguished for stock-keeping and other purposes by different colored tags, as follows:

No. 1, blue tag, coated Armco iron. This is used for work where ductility and toughness are desired and is recommended particularly for cast iron welding. It is equally suitable for steel plates and steel castings.

No. 3, gray tag, coated mild steel. This grade is employed for general welding in all positions, particularly flues, fire boxes, steel plates, steel tanks and boilers. It is also recommended for welding low-carbon steel castings.

No. 5, green tag, coated medium-carbon steel. Used for work where limited abrasive wear is encountered such as worn surfaces of axles.

No. 7, red tag, coated high-carbon steel. This grade is used on parts where high resistance to abrasive wear is desired, such as rails, frogs, driving wheel tires, and so on. Welding should be done with the electrode positive (reversed polarity).

No. 9, orange tag, coated manganese steel. These electrodes are used where extreme toughness and medium hardness are desired. They are of special value in the reclaiming of worn manganese steel frogs, inserts, switch points, and like parts. Welding is done with the electrode positive (reversed polarity).

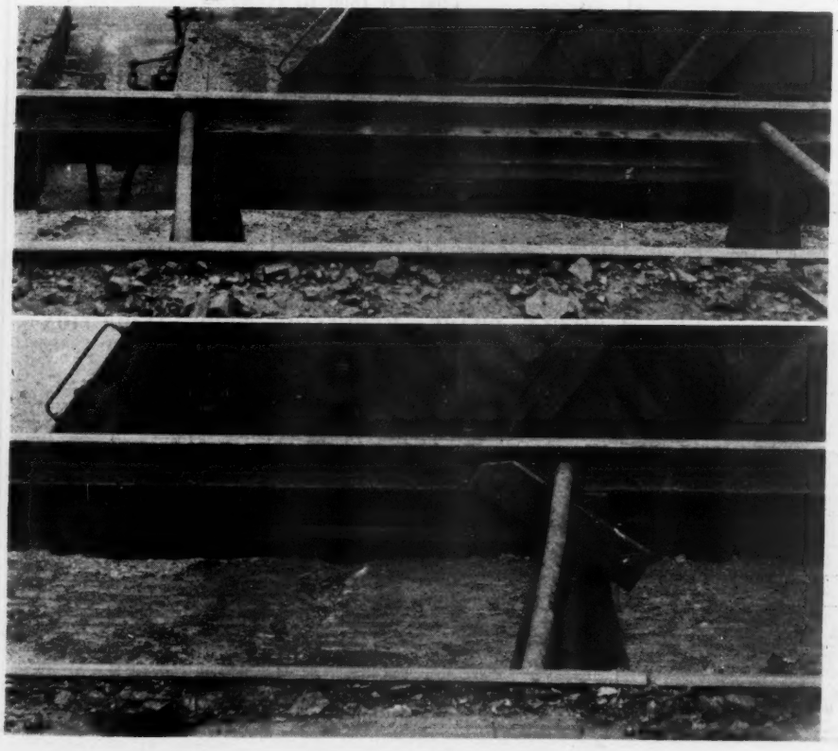
AVERAGE COMPOSITION OF WANAMAKER COATED ELECTRODES*

No.	Sul.	Phos.	Mang.	Carbon	Sil.
1	.025%	.005%	.025%	.01%	.005%
3	.05 max.	.05 max.	.30-.60	.10-18	.08 max.
5	.05 max.	.05 max.	.30-.60	.25-.35	.08 max.
7	.04 max.	.04	.60-.90	.60-.75	.08
				.90-1.10	
9	.05 max.	.05	12.0-14.0	.95-1.10	.08

*Data furnished by the Transportation Engineering Corporation.

The electrodes are 14 in. long and are stocked in the following sizes: 3/32 in., 1/8 in., 5/32 in., 3/16 in., 1/4 in., 5/16 in. and 3/8 in.

[In another section of this article the welding procedure in different work as carried out in the Rock Island shops will be outlined.—Editor.]



Here is a place where rivets have been displaced by arc welding.

One side of the track in the cinder pit is supported on heavy iron standards. The required strength is secured by the use of two rails fastened together at the base. This was formerly done by riveting, as shown in the upper illustration. The lower illustration shows how the rails are now joined by welding, at a fraction of the cost of the riveting.

Wiring Data for Direct and Alternating Current Motor Circuits

(*Continued from page 128, March, 1922, Issue*)

SINGLE-PHASE, SPLIT-PHASE TYPE, INDUCTION MOTORS—110 VOLTS, 60 CYCLES

H. P.	Speed, R.P.M.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	1750	15	8	60	40	20	1
	870	17	8	60	45	25	1
2	1750	24	6	60	60	30	1
	870	33	6	100	70	45	1
3	1750	34	6	100	70	45	1¼
	1165	40	4	100	80	50	1¼
5	1750	52	2	200	110	65	1¼
	870	66	1	200	150	85	1½
7½	1750	79	0	200	175	100	1½
	870	96	0	200	200	125	1½
10	1750	104	00	400	225	150	2
	870	124	000	400	250	150	2
15	1750	150	200,000	400	300	200	2
	870	178	300,000	400	375	225	2½

SINGLE-PHASE, SPLIT-PHASE TYPE, INDUCTION MOTORS—220 VOLTS, 60 CYCLES

H. P.	Speed, R.P.M.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	1750	7	12	30	25	10	¾
	870	8.5	12	30	25	12	¾
2	1750	12	8	60	35	15	1
	870	16.5	8	60	45	25	1
3	1750	17	8	60	45	25	1
	1165	20	8	60	50	25	1
5	1750	26	6	100	65	35	1
	870	33	6	100	70	45	1
7½	1750	40	4	100	90	50	1¼
	870	48	2	100	100	60	1¼
10	1750	52	2	200	110	65	1¼
	870	59	0	200	125	75	1¼
15	1750	75	1	200	150	95	1½
	870	89	0	200	175	110	1½
20	1750	103	00	400	225	150	2
	870	119	000	400	250	150	2
25	1750	115	000	400	250	145	2
	870	119	000	400	250	150	2
30	1750	132	000	400	275	175	2
	1165	133	000	400	275	175	2
35	1750	149	200,000	400	300	200	2
40	1750	165	300,000	400	350	225	2½

Current values for Wagner motors are used up to 20 H. P. and those for Century motors above 20 H. P.

IN THE ARTICLE by H. L. Cornelison beginning on page 127 of the March, 1922, issue, entitled "Information That You Need When Wiring for Motors in Ordinary and Special Service," tables similar to those on this page were included for 110, 220 and 550-volt direct current motors; and for 110, 220, 440, 550 and 2200-volt, 60-cycle, three-phase, squirrel-cage induction motors. These tables apply to 40-deg. motors and have been based upon those compiled by F. D. Weber, Chief Electrical Engineer, Oregon Insurance Rating Bureau, Portland, Ore. Mr. Weber gives the following procedure as a basis for compiling the data which was originally presented by him in a booklet for 50-deg. motors.

He points out that in converting the tables to apply to 40-deg. motors and to obtain the running fuse for 50-deg motors from this data, an error was made at the bottom of page 128 of the March, 1922, issue, in the following statement: "To obtain running fuse for 50-deg. motor divide full load current by 1.32 and use nearest commercial size." The word divide should be multiply and the constant 1.044 instead of 1.32. In explaining the correct procedure he says:

"The full load current for both the 40-deg. and the 50-deg. motors for the same horse-power rating is

SINGLE-PHASE, REPULSION-TYPE, INDUCTION MOTORS, 110 VOLTS, 60 CYCLES—SPEED 1200 TO 1800 R. P. M.

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	11.2	8	60	50	15	1
2	20	6	100	65	25	1
3	28	4	100	75	35	1¼
5	45	4	100	90	60	1¼
7½	65	1	200	150	85	1½
10	84	0	200	175	110	1½
15	122	000	400	250	150	2

SINGLE-PHASE, REPULSION-TYPE, INDUCTION MOTORS, 220 VOLTS, 60 CYCLES—SPEED 1200 TO 1800 R. P. M.

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
*1	5.6	12	30	25	10	¾
*2	10	10	60	35	15	¾
3	14	8	60	40	20	1
5	22.5	6	60	60	30	1
7½	32.3	6	100	75	40	1
10	42	4	100	90	50	1¼
15	61	2	200	125	75	1¼

*Current values for General Electric motors are used.

identical, but they have different temperature rises. Consequently, when it is desired to determine the current that is necessary to produce a 40-deg. rise in temperature in a 50-deg. motor, using the 40-deg. motor as a basis, the current to produce same will be 5/6 of the normal full load current rating. For example:

"A 30-hp., 220-volt, 3-phase, 60-cycle, squirrel-cage type induction motor has a full load current of 75 amperes for both a 40-deg. and a 50-deg. temperature rise. Therefore, 5/6 ×75 equals 62.5 amperes full load current in a 50-deg. motor to produce 40-deg. rise in temperature. Then adding 25 per cent (according to Rule 8, National Electrical Code) we have 78.12 amperes as the size of running fuse. Hence, the constant is 78.12, divided by 75 equals 1.044, and it is necessary to multiply by 1.044 instead of dividing by 1.32 to obtain the running fuse."

The tables which Mr. Weber prepared and were originally referred to in the article of the March issue on page 154 were compiled as follows:

The full load current of 75 amperes for a 50-deg. motor multiplied by 1.32 equals 99 amperes running fuse for a 40-deg. temperature rise motor, using the 50-deg. motor as a basis. This was obtained in the following manner:

Full load current of 75 amperes multiplied by 6/5 equals 90 amperes full load current in a 40-deg. motor to produce a 50-deg. rise in temperature. Then, as the manufacturers do not guarantee an overload capacity exceeding 10 per cent in the case of a 50-deg. rise, add 10 per cent and 99 amperes is obtained for the running fuse size.

On page 129 the following statement is made: "For motors which take less than 30 amperes on full load, the starting current is figured as 250 per cent of full load, and for those which take over 30 amperes the starting current is 200 per cent of full load current, etc."

Since the starting currents are generally much higher, a better statement would be as follows: The necessary current carrying capacity of conductors will be equal to the following percentages of the "current rating" on motor name plates:

0 to 30 amperes=250 per cent,
Above 30 " =200 per cent
Small motors when thrown directly on the line=300 per cent.

TWO-PHASE INDUCTION MOTORS—3 WIRE, COMMON RETURN, 110 VOLTS, 60 CYCLES, STANDARD SPEEDS

H.P.	Full-Load Current Amp.		Size of Wire, B. & S. Gage		Size of Switch, Amp.	Size of Starting Fuses, Amp.		Size of Running Fuses, Amp.		Conduit Size, In.
	Outside Wires	Common Return	Outside Wires	Common Return		Outside Wires	Common Return	Outside Wires	Common Return	
	For 110 Volt Circuits									
1	5.2	7.33	14	14	30	15	20	10	10	½
2	10.4	14.67	12	10	60	30	40	15	25	¾
3	15.6	22	8	6	60	40	60	20	25	1
5	22.2	31.3	6	4	100	60	80	30	40	1¼
7½	33.8	47.7	6	4	100	70	100	40	60	1¼
10	44.2	62.3	4	2	200	90	125	60	75	1½
15	64.8	91.5	2	0	200	125	175	85	125	1½
20	87.5	123	1	00	400	175	250	110	175	2
25	108.2	152.6	0	200,000	400	225	300	150	200	2
30	129.8	183	00	0000	400	250	350	165	225	2½
35	151.4	213.5	000	400,000	400	300	450	200	275	2½
40	181.7	256	300,000	500,000	*600	375	550	225	325	3
50	213	301	300,000	500,000	*800	450	*602	275	400	3
	For 220 Volt Circuits									
1	2.6	3.67	14	14	30	10	10	10	10	½
2	5.2	7.34	14	14	30	15	20	10	10	½
3	7.8	11.0	12	10	60	20	30	10	15	¾
5	11.1	15.65	10	10	60	30	40	15	20	1
7½	16.9	23.9	10	8	60	40	60	25	30	1
10	22.1	31.2	8	6	100	55	65	30	40	1
15	32.4	45.7	6	4	100	65	90	45	60	1¼
20	43.75	61.8	4	2	200	90	125	60	80	1½
25	52.1	73.6	4	1	200	100	150	65	95	1½
30	64.9	91.7	2	0	200	125	175	85	125	1½
35	75.7	106.7	2	00	400	150	225	100	145	1½
40	90.8	128	1	000	400	175	250	125	175	2
50	106.5	150	00	000	400	225	300	150	200	2½
75	161	227.5	200,000	300,000	*600	325	450	200	300	2½
100	210	297	350,000	500,000	*600	450	*600	275	375	3
150	315	444	600,000	900,000	*1000	*630	*888	400	*600	4

TWO-PHASE INDUCTION MOTORS, 110 VOLTS, FOUR WIRE, 60 CYCLES, STANDARD SPEEDS

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	5.2	14	30	15	10	¾
2	10.4	12	30	30	15	¾
3	15.6	10	60	45	20	1
5	22.2	8	100	65	30	1
7½	33.8	6	100	85	45	1¼
10	44.2	4	100	90	60	1½
15	64.8	2	200	125	85	1½
20	87.5	1	200	175	110	2
25	108.	0	200	225	125	2
30	129.8	00	400	250	175	2½
35	151.4	000	400	300	200	2½
40	181.7	300,000	400	375	225	3
50	213	400,000	*600	*450	275	3½
75	322	500,000	*800	*644	400	3½

*When fuse sizes exceed 600 amperes, circuit breakers of approved type must be substituted.

TWO-PHASE INDUCTION MOTORS, 220 VOLTS, FOUR WIRE, 60 CYCLES, STANDARD SPEEDS

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	2.6	14	30	10	10	¾
2	5.2	14	30	15	10	¾
3	7.8	12	30	25	10	¾
5	11.1	10	60	35	15	1
7½	16.9	10	60	40	20	1
10	22.1	8	60	55	30	1
15	32.4	6	100	65	40	1¼
20	43.75	4	100	90	55	1½
25	52.1	4	100	100	65	1½
30	64.9	2	200	125	85	1½
35	75	2	200	150	95	1½
40	90.8	1	200	200	110	2
50	106.5	00	400	225	150	2½
75	161	200,000	400	325	200	3
100	210	400,000	600	450	275	3½
150	315	600,000	*800	*630	400	4

From this dispatching board 135 motors ranging in size from 1 to 225 hp. are started and any circuit may be tested when troubles develop.

ORVILLE F. LONG *Explains Why He Adopted*

Central Control of Motors

and Uses Circuit-Breakers and Relays or Oil Switches Instead of Fuses

IN THE design of distribution and control systems for industrial plants there are a number of important factors to be considered, such as the number of units to be controlled, their size, the probable load factor, the area of floor space to be covered, class of work to be done, and so on. It should be of interest to note how these factors were taken care of in the recently completed body plant of the Kelsey Wheel Company, Inc., Memphis, Tenn., which is equipped according to the most modern ideas in the electrical design of lighting and motor control. The main objects considered in the design of this installation were: 1, low initial cost; 2, safety to employees; 3, flexibility; 4, standardization; 5, accessibility of equipment after installation; and 6, releasing the employee on each machine of the responsibility of handling electrical equipment.

In selecting the voltage to be used in the plant, 440 volts, three-phase, was decided upon for several reasons. First, the initial cost was about one-third of that for standard 220-volt, three-phase installation of the same type. Second, smaller conduits, wires and cables could be used, thus requiring less space. Third, the voltage drop on long runs was less than that at 220 volts, there being not over a 5-volt drop between the switchboard and the end of the longest run, which is about 1,200 feet.

THE DISTRIBUTION and control system described here provides for the starting of all motors from a central dispatching switchboard designed to facilitate testing of individual units and render the detection of grounds and other faults almost automatic.

The layout of the system and the use of special connectors make it easy to replace equipment.

For small motors circuit breakers and relays are used instead of fuses and for large motors an oil switch.

Mr. Long is superintendent of power for the Kelsey Wheel Company, Inc., Memphis, Tenn., and has had wide experience in the installation of electrical equipment in industrial plants.

Perhaps the most unusual feature of the installation is the main switchboard from which all motors are started and from which any circuit may be tested for faults or in obtaining data for use in piece-work calculations. To assist in this testing a sectionalized grounding-circuit is run the entire length of the plant. Another feature is that circuit-breakers and relays are employed with all motors in place of fuses.

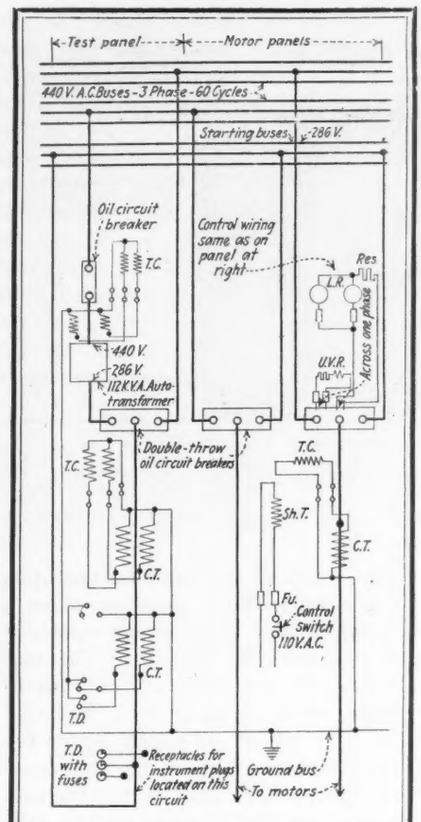
In a body-making plant it is at times necessary to relocate certain machines on account of changes in

design of the bodies, and for this purpose a tunnel 6 ft. square was run the full length of the Memphis plant, which is 501 ft. long and 200 ft. wide in the wing in which the motor drives are located. The other wing is 461 ft. long and 240 ft. wide, the plant being laid out in the shape of an L. This tunnel through the center of the plant also runs through the different sheds and kilns which are built around the main plant. The tunnel offers a convenient means for running all wires, conduits and lead-covered cables as well as steam and water lines. They are carried from the power-dispatching board through the tunnel to the point nearest the machine for which they are intended.

All Motors Are of Same Type

All motors are of the same type, the form "K.T" made by the General Electric Company, which are rated at 440 volts, three-phase, and 50 deg. rise. There are 135 motors ranging in size from 1 hp. to 225 hp. and totaling 1,493 hp. connected load. By adopting a standard type a smaller stock of repair parts is required and time is saved in replacing damaged parts. Before the motors were placed on the machines a thorough investigation into the power requirements was made so that each motor would be of the proper size. All machines have individual drive, the motor being connected to the circuit by a General Electric motor connector, which makes it possible to disconnect the motor from the circuit in a few seconds in case of replacement or repairs.

The conductors of rubber-covered wire are carried in rigid conduit from the motor to a junction box placed 1 ft. above the floor on a column used for roof support. These posts are spaced on 20-ft. centers throughout the entire plant so that a box can be installed at any convenient point. In this box a junction is made between the rubber-covered wire and the lead-covered cable which runs through the tunnel to the switchboard. The radial system of distribution was selected for this plant on account of its flexibility, ease of operation and safety of control, the accessibility of all machines, and also because this is a practicable arrangement for use with the central dispatching board shown at the top of page 180.



One-line diagram of wiring on a section of dispatching switchboard. There are three sections like this. Each section has one test panel and several motor panels from which run a number of motor circuits. Only two motor circuits are shown. The following abbreviations are used in the drawing: C. T. = current transformer; Sh. T. = shunt trip coil; T. C. = trip coil; T. D. = testing device. The control wiring is shown complete (not by a one-line diagram) as it should be on three-phase circuits.

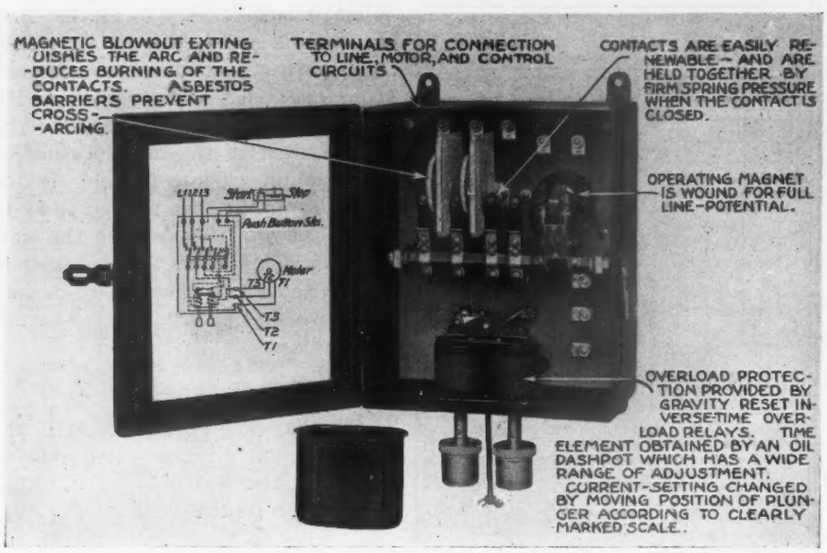
When it is necessary to move a machine from one location to another, the overhead conduit is removed from one post and, together with the junction box, is fastened to the post nearest to the new location of the machine. The lead cable inside of the tunnel is then spliced so as to reach the junction box at the new location. This offers an easy method of changing the position of a machine without pulling wire in or out of conduits.

Method of Running Cables

All the cables run through the tunnel on cable racks placed every 6 ft. along the wall and at different heights from the floor to the ceiling. They all pass from the tunnel to the switchboard room underneath the floor in forty-three 3-in. fiber ducts. From these ducts they pass into an 18-ft. junction box inside the switchboard room, behind the switchboard. The cables pass into the box at the bottom and are fastened by Dossert connectors to the rubber-covered wires which run from the junction box through iron conduit to the different panels of the switchboard. These Dossert connectors are also used in the junction boxes at the motor end of the circuit. They allow quick and easy changes in case of damaged equipment and when a relocation is found necessary.

The switchboard room is 80 ft. long and 20 ft. wide, and the power switchboard of twenty-four panels runs along the greater part of one side. The lighting switchboard is at right angles to the power switchboard at one end of the room. All motors are started by the operator

At the left of each of these band saws typical installations of remote control circuit breakers and safety switches are shown.


MAGNETIC BLOWOUT EXTINGUISHES THE ARC AND REDUCES BURNING OF THE CONTACTS. ASBESTOS BARRIERS PREVENT CROSS-ARCING.
TERMINALS FOR CONNECTION TO LINE, MOTOR, AND CONTROL CIRCUITS
CONTACTS ARE EASILY RENEWABLE — AND ARE HELD TOGETHER BY FIRM SPRING PRESSURE WHEN THE CONTACT IS CLOSED.
OPERATING MAGNET IS WOUND FOR FULL LINE-POTENTIAL.
OVERLOAD PROTECTION PROVIDED BY GRAVITY RESET INVERSE-TIME OVERLOAD RELAYS. TIME ELEMENT OBTAINED BY AN OIL DASHPOT WHICH HAS A WIDE RANGE OF ADJUSTMENT. CURRENT-SETTING CHANGED BY MOVING POSITION OF PLUNGER ACCORDING TO CLEARLY MARKED SCALE.
L1 L2 L3
Start
Stop
Push Button Sta.
Motor
T3
T2
T1

Remote control magnetic switch with inverse-time relays used for starting small a. c. motors in Memphis plant of Kelsey Wheel Company.

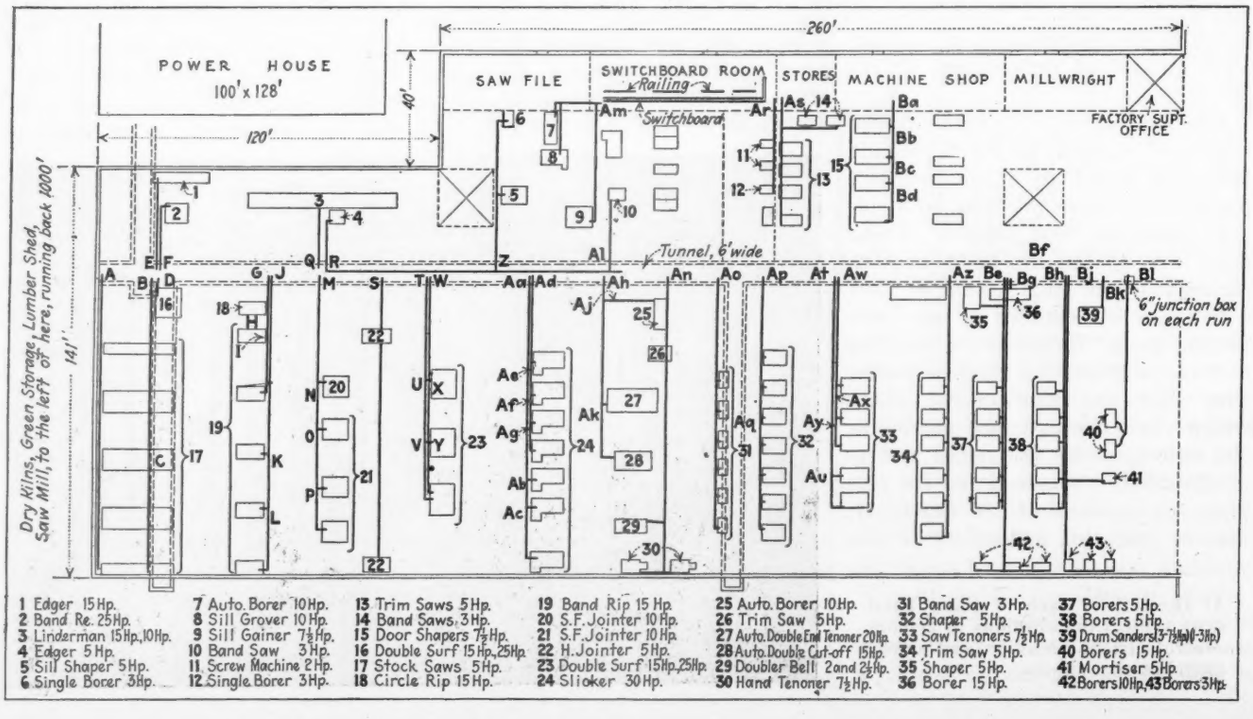
at this board, with the exception of those under 7½ hp. in rating, which are started and stopped by push-buttons operating a General Electric magnetic switch. Of such switches there are approximately seventy. These small motors controlled by magnetic switches are divided up into circuits of from four to eight motors to a circuit, depending on the size. For instance, there are four 7½-hp. motors, six 5-hp. motors or eight 3-hp. motors per circuit. These circuits are in turn controlled by an oil circuit-breaker on the power-dispatching board. All larger motors are controlled individually from the power-dispatching board.

On every machine is a "start" and "stop" push-button switch within easy reach of the machine operator. The operator of a machine gives a signal to the switchboard operator by pushing the button at the machine. At the desk of the switchboard operator there is a "telltale" board on which are signal lamps for every circuit. When a machine operator pushes a "start" button the corresponding lamp lights on the telltale board. There is also a pilot lamp in parallel with this on the motor panel. When the switchboard operator sees his lamp light he goes to the proper panel and starts the motor by throwing in the starting switch. When the meter which is on the testing panel shows "run," he throws in the running side of the oil switch, which automatically releases the starting side, and the motor is in operation.

Motor layout in Memphis plant of Kelsey Wheel Company.

Starting and Testing of Motors

An inspection of the diagram of the power circuits on the switchboard shows how starting and testing are accomplished. Before starting any motors the double-throw switch on the test panel is thrown to the left. This puts about 286 volts on the lowest bus, which is the starting bus. Then the double-throw circuit-breaker on the motor which is to be started is thrown into the position indicated at the right in the diagram. This puts 286 volts on the motor. When the motor is up to speed, the motor circuit-breaker is thrown to the left position, which puts 440 volts on the motor. If it is desired to test the load on any motor, this may be done without disturbing its operation. The double-throw breaker on the test panel is first thrown to the right and this puts 440 volts on the starting panel. Then the breaker on the motor panel is thrown to the right, so that the motor draws its current from the lowest bus, which is now energized with 440 volts.


260'
POWER HOUSE
100' x 128'
40'
120'
SAW FILE
SWITCHBOARD ROOM
Railing
Switchboard
STORES
MACHINE SHOP
MILLWRIGHT
FACTORY SUPT. OFFICE
Tunnel, 6' wide
Dry Kilns, Green Storage, Lumber Shed, Saw Mill, to the left of here, running back 1000'
141'
6" junction box on each run
1 Edger 15 Hp.
2 Band Re. 25 Hp.
3 Linderman 15 Hp., 10 Hp.
4 Edger 5 Hp.
5 Sill Shaper 5 Hp.
6 Single Borer 3 Hp.
7 Auto. Borer 10 Hp.
8 Sill Grover 10 Hp.
9 Sill Gainer 7½ Hp.
10 Band Saw 3 Hp.
11 Screw Machine 2 Hp.
12 Single Borer 3 Hp.
13 Trim Saws 5 Hp.
14 Band Saws, 3 Hp.
15 Door Shapers 7½ Hp.
16 Double Surf 15 Hp., 25 Hp.
17 Stock Saws 5 Hp.
18 Circle Rip 15 Hp.
19 Band Rip 15 Hp.
20 S.F. Jointer 10 Hp.
21 S.F. Jointer 10 Hp.
22 H. Jointer 5 Hp.
23 Double Surf 15 Hp., 25 Hp.
24 Slicker 30 Hp.
25 Auto. Borer 10 Hp.
26 Trim Saw 5 Hp.
27 Auto. Double End Tenoner 20 Hp.
28 Auto. Double Cut-off 15 Hp.
29 Doubler Bell 2 and 2½ Hp.
30 Hand Tenoner 7½ Hp.
31 Band Saw 3 Hp.
32 Shaper 5 Hp.
33 Saw Tenoners 7½ Hp.
34 Trim Saw 5 Hp.
35 Shaper 5 Hp.
36 Borer 15 Hp.
37 Borers 5 Hp.
38 Borers 5 Hp.
39 Drum Sanders (3-7½ Hp. 1-3 Hp.)
40 Borers 15 Hp.
41 Mortiser 5 Hp.
42 Borers 10 Hp., 43 Borers 3 Hp.

By tracing the circuits it will be noted that the current for the motor flows through the test panel, on which are plug receptacles for instruments. The readings are taken from instruments which are plugged in on these test panels from a portable benchboard on wheels which carries meters, transformers, and so on. If it is desired to measure the current of this motor while starting, the motor is shut down by opening its oil circuit-breaker; then the double-throw breaker on the test panel is thrown to the left and the breaker on the motor panel is thrown to the right. This puts 286 volts on the motor, and the current is drawn through the test panel so that a reading may be taken. When the motor is up to speed, the double-throw breaker on the test panel is switched to the right-hand position, which puts 440 volts on the motor, but still allows the current to the motor to be measured.

As the current for starting in the ordinary manner is drawn through the test panel, the operator may watch an ammeter to determine the correct time for throwing in the motor switch from the starting position to the running position.

Starting Current Is Supplied by Auto-Transformers

The starting current is supplied by auto-transformers installed outside the switchboard room on a platform together with three lighting transformers. These are three-phase, 112-kva., each connected for

TABLE I—Size of Conduit and Wiring in Woodworking Mill

Conduit Run	Size Conduit, In.	No. of Wires	Size Wires, B & S Gage No.*	No. of Motors	Hp. of Each Motor	Machines Driven
A	2½	6	2			
B	2	6	4	8	5	8 stock saws
C	1½	3	4			
D	2½	3	4	1	25	Double surfacer
		3	6	1	15	
		6	14			
E	1½	3	6	1	15	Edger
		3	14			
F	1½	3	4	1	25	Band rip
		3	14			
G	2½	9	6			
		9	14			
H	2	6	6	1	15	Circle rip
		6	14	2	15	2 band rips
I	1½	3	6			
		3	14			
J	2½	9	6			
		9	14			
K	2	6	6	3	15	3 band rips
		6	14			
L	1½	3	6			
		3	14			
M	2½	12	8			
		12	14			
N	2	9	8	4	10	4 S. F. joiners
		9	14			
O	1½	6	8			
		6	14			
P	1¼	3	8			
		3	14			
Q	2	3	8	1	10	Linderman
		3	6	1	15	
		6	14			
R	1¼	3	8	1	5	Edger
S	1¼	3	8	2	5	2 H. jointers
T	2½	9	6			
		9	14			
U	2	6	6	3	15	
		6	14			
V		3	6			3 double surfacers
		3	14			
W	2½	9	4			
		9	14			
X	2	6	4	3	25	
		6	14			
Y	1½	3	4			
		3	14			
Z	1¼	3	8	1	5	Sill shaper
				1	3	Single borer
Aa	2½	9	4			
		9	14			
Ab	2	6	4	3	30	3 stickers
		6	14			
Ac	1½	3	4			
		3	14			
Ad	3	12	14			
		12	14			
Ae	2½	9	4	4	30	4 stickers
		9	14			
Af	2	6	4			
		6	14			
Ag	1½	3	4			
		3	14			

Conduit Run	Size Conduit, In.	No. of Wires	Size Wires, B & S Gage No.*	No. of Motors	Hp. of Each Motor	Machines Driven
Ah	2½	6	8	1	10	Auto borer
		3	6	1	20	Auto. double-end tenoner
		9	14	1	15	Auto. double cut-off
Aj	1½	3	8			
		3	14			
Ak	1½	3	8			
		3	14			
Al	1½	3	8	1	3	Band saw
Am	2	3	6	1	15	Sill grover
		3	8	1	10	Auto. borer
		3	10	1	7½	Sill gainer
		9	14			
An	1½	3	6	2	2½	Douber bell
				1	2	
				2	7½	2 hand tenoners
Ao	1½	3	6	6	3	6 band saws
Ap	1½	6	6			
Aq	1½	3	6	7	5	7 shapers
Ar	1½	3	6	2	2	2 screw machines
				1	3	Single borer
As	1½	3	4	4	5	4 trim saws
				2	3	2 band saws
At	1½	6	10	2	7½	
Au	1½	3	10			2 saw tenoners
Aw	2	9	10			
		9	14			
Ax	1½	6	10	3	7½	3 saw tenoners
		6	14			
Ay	1½	3	10			
		3	14			
Az	1½	3	4	6	5	6 trim saws
Ba	2½	12	10			
		12	14			
Bb	2	9	10			
		9	14			
Bc	1½	6	10	4	7½	4 door shapers
		6	14			
Bd	1½	3	10			
		3	14			
Be	1½	3	4	6	5	Shaper
						Borer
						4 trim saws
Bf	1½	3	8			
		3	14	1	10	3 borers
Bg	1½	3	6			
		3	14	1	15	Borer
Bh	2	3	2	5	5	Borer
						4 trim saws
Bj	1½	3	4	3	3	3 borers
				1	5	Mortiser
Bk	1½	3	4	1	3	
				3	7½	Drum sander
Bl	1½	3	6			
		3	14	1	15	2 borers

*The No. 14 wires are for the push-button control circuits.

Letters in first column refer to drawing of machine and conduit layout.

65 per cent voltage of the low-tension side. There are three of these transformers, one for each of the sections into which the power switchboard is divided. It is possible to start several motors at once in each of these sections. Provision is made in case of failure of any switch, transformer or feeder to cut it out of service and put in either a reserve unit or transfer to another unit simply by loosening a Dossert connector and inserting the reserve unit. Having feeders, switches, motors, and so on, equipped with these connectors makes it an easy matter to cut any machine out of service and make a substitution. There are two sets of buses to each power section, one being at 440 volts for running and the other at 65 per cent of this for starting only.

If the machine operator wishes to stop his machine, he simply pushes his "stop" button, which operates the shunt trip-coil in the oil-switch on the power-dispatching board, releasing the oil-switch and thereby stopping the motor. The switchboard operator also may stop the motor by means of a similar button on his telltale board. Each control button is equipped with a spring lock which holds the "stop" button down, making it impossible to operate the motor. If the oil-switch is thrown in by mistake, no current can flow through the line until the "stop" button is released, which must be done before a "start" signal can be given. In case the control button should fail to operate properly, the motor can be stopped by opening a "Square D" safety switch, one being placed near each motor. Another feature that makes for safety is that the safety switch can be locked in the "off" position. This is taken advantage of when repairs are being made.

Circuit Breakers and Relays Replace Fuses

All circuits are controlled by an oil circuit-breaker on the power-dispatching board, and where more than one motor is on a circuit each motor is protected by its own relay. From the production standpoint this method of protection is better than the use of fuses. When a fuse blows, an electrician must be sent to a point near the machine. In the course of a year the time thus consumed and the loss in production amounts to a considerable expense. In an accompanying table is shown the cost of fuse renewals in a large plant having seventy-five motors totaling 750 hp. Such an expense would go a long way toward the additional cost of the initial expense of the installation of relays in place of fuses. This system costs about 20 per cent more than the fuse system with ring feeders or radial feeders with cut-outs and fuses in cabinets near the motor.

TABLE 2—Annual Cost of Replacing Fuses in Woodworking Plant Having Seventy-five Motors.

Costs are based on the use of non-renewable fuses.

Amp. Size of Fuses	No. Fuses Used	Cost of Fuses	Total Hours Delay
6	200		35
10	300		50
15	150	$260.00	25
20	150		25
30	500		84
45	100		17
60	675	$348.75	113
75	225		38
100	120	$172.50	20
125	100		17
150	200		35
175	100	$855.00	17
200	50		9
250	20	$114.00	3
300	10		2
400	8		2
Total	2,908	$1,750.25	492

Fuse cost	$1,750.25
Estimated production loss at $1 per hour	492.00
Labor cost, at $0.75 per hour	369.00
Total cost	$2,611.25

Grounding-Circuit Saves Time in Locating Trouble

Another feature of the installation which saves time in locating trouble is a complete grounding-circuit which is carried throughout the entire plant, with a signal system connected to the telltale board so as to give warning of any ground which may develop and with an arrangement by which the ground may be quickly located. The ground wire consists of a 250,000-circ.mil cable running the full length of the plant inside the tunnel. All conduits, cable sheaths, boxes, motors and machines are grounded to this cable. The cable is divided into a number of sections, and each one of these sections is grounded to a permanent ground through a solenoid, as shown in the accompanying diagram.

Whenever a ground develops on one section of the cable the two solenoids on each end of this section release the switches on the ends of the sections, thus isolating this section from the rest of the ground wire.

When these switches are released, they are forced by springs into contact with other switch clips, which are connected to the telltale board, where they cause lamps to light. The opposite side of these lamps is connected to the non-grounded side of a 110-volt circuit so that when the ground-cable is connected to the first side of the lamps they will light. There are also three other signal lamps on this board connected to the ground side of the solenoids. These lamps connect through resistances to each phase of the 440-volt bus. When one phase of a circuit is grounded, for instance, at the motor, this will cause the light on that phase to become dark. When the two switches on the section of the ground-cable open, the dark light will indicate at which section the ground is present.

Repair and Maintenance

A complete repair shop for taking care of all repairs, armature winding, testing, construction and other maintenance was installed at the plant. Inspection crews make their regular trips through the plant to note any trouble and in turn make reports at the end of each trip to the chief operator, who is responsible for the continuity of service and for production.

THE CRANE shown above unloads scrap iron as well as pig iron. Energy for the magnet is obtained from a small generator mounted in the cab. Scrap and pig iron are hauled from piles of stock such as shown at the right above, to the foundry by storage-battery locomotives. Spur tracks serve all stock piles as well as coke bins from which cupola fuel is taken.

How Electric Trains Are Used in

Moving 300 Tons of Material Daily

into a Large Foundry and Through Assembling Departments

UNDER normal operating conditions a total of 250 to 300 tons of pig iron and scrap material is used per day at the plant of the Oliver Chilled Plow Works, South Bend, Ind. It is unloaded from railroad cars by the aid of a locomotive crane and a 42-inch electromagnet. All of this material is stacked along spurs from an industrial track system leading into the foundry. The pig iron is stacked in piles along the track, while the scrap is put in separate piles, the different general classes of material being segregated. From these stock piles the material is loaded by hand into the industrial cars that are run onto the spurs beside the piles. These cars are handled, both empty and loaded, by four storage-battery locomotives. The loaded cars are hauled into the foundry to the weighing floor, where the various elements of pig and scrap are weighed into charges to provide a proper mix for the finished products.

From this weighing floor the cars carrying properly made-up charges are pulled or pushed onto an elevator by small storage-battery tractors. This elevator delivers the material up to the charging floor. Coke for fuel is handled in the same manner, the weighing being done by the same scale. All material is charged by hand direct from the cars in which it leaves the weighing floor.

FOUR INDUSTRIAL locomotives operated by storage batteries, and eleven industrial electric tractors, have made possible at the Oliver Chilled Plow Works a flexible transportation system for handling quantities of materials in the different steps of production from the raw state to the final assembled product. They have practically eliminated local storage in bins and racks by making it possible to mount such bins and racks on wheels and keep their contents constantly moving through production and assembly departments. This system saves much time and labor and has speeded up production in all departments from the receiving yards to the shipping platform.

Melted iron drawn from the cupolas is discharged in 1,000-lb. batches into large ladles suspended from an overhead track in front of the spout. This track is arranged so that more than one ladle can be brought up at once, and extensions of the track run above all the main aisles of the foundry floor. These large ladles when filled are run out and emptied into smaller ladles, also suspended from smaller overhead rails running at right angles to the main rails carrying the large ladles. The molds are set up in rows on each side of alleyways below the small overhead rails and are filled from the smaller ladles.

The castings from the molds are loaded into iron boxes suspended from trolleys similar to those carrying the large ladles and are run out into the mill room. Here the rough castings are placed directly in rat-

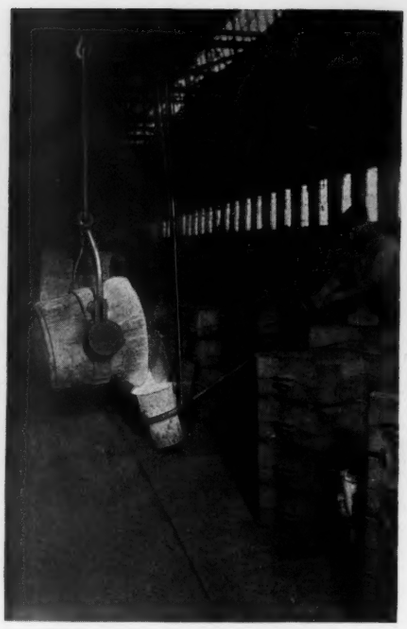
Overhead rails carry large ladles serving the cupolas.

This overhead rail system goes to all parts of the foundry floor and out into the mill room. Hot castings are carried from the foundry mill room in suspended boxes.

tlers. After the rattling is finished the pieces are loaded into wheeled wooden trucks and pushed across the aisle to grinders, where rough spots are removed and a general dressing down is completed, or are sent direct to some other process if grinding is not required. Each piece as it is finished is placed in a waiting truck at the side of the grinder. As truckloads of finished pieces accumulate they are picked up by the battery-operated tractors and are hauled away to another process.

Much of the material leaving the grinders is moved a considerable distance to other buildings. For this purpose standard railroad cars are employed. The small trucks are hauled up an incline onto a loading platform and into the car. A switch engine shifts the loaded railroad cars to their assigned destination, where the small trucks are again picked up and moved into production or sent into stock.

Assembly processes are carried on in part on assembly stands and in part with the work suspended from trolleys running on an overhead-rail system. The various parts are taken directly from the wheeled trucks making up the tractor trains, or from boxes carried on the wheeled trucks, and are attached to the "work" as it progresses through the assembly department. Completed plows are dip-painted in quantities by a special rig built into an overhead trolley system. A group of plows is pushed over the dipping tank and is then lowered with a section of the rail into the paint, the rail being lowered and raised by an air hoist. The painted units pass onto storage rails (*Continued on page* 207.)



Small overhead rails carry small ladles for pouring molds.

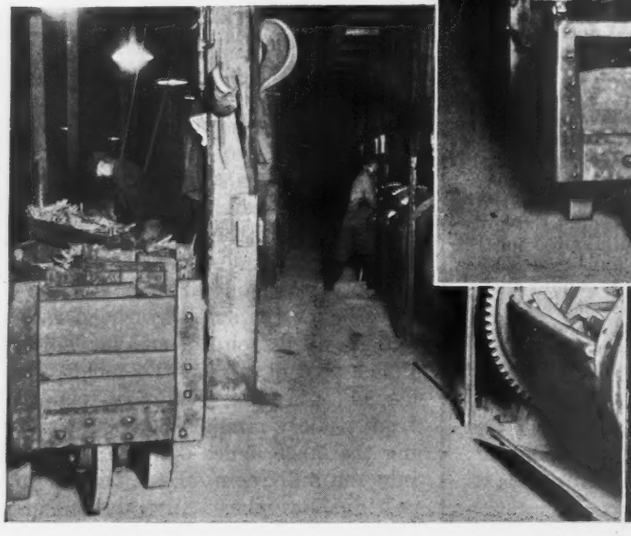
This arrangement eliminates much of the hard work encountered in the rush of pouring the heat. It also greatly reduces the chances of a spill, causing injury to the workmen.

Tractor hauling trucks up incline to car-loading platform.

Small loaded trucks are placed directly into railroad cars for shipment to other parts of the plant. This eliminates long hauls over rough and graded roadways for the loaded tractors.

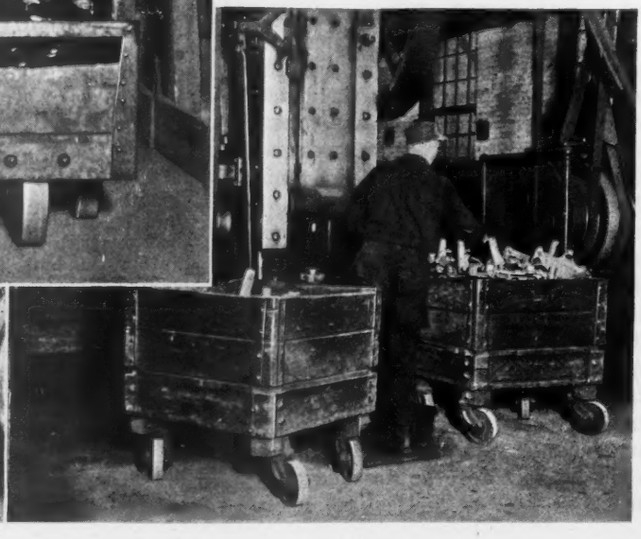
Mill room where rough castings are rattled and ground.

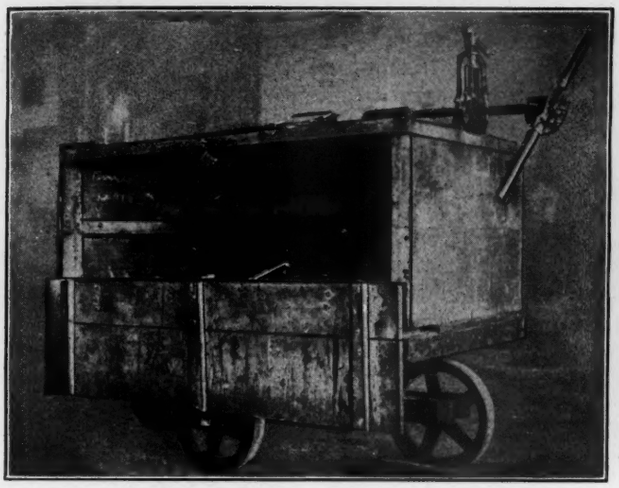
Rough castings are carried into this room in iron boxes suspended from the overhead rail. The castings are placed directly in the rattlers from the iron boxes. Castings removed from the rattlers are loaded into wheeled trucks and pushed across the aisle to the grinders. Ground pieces are tossed into other trucks.



Trucks are used as raw material and finished work stock bins.

This man is taking rough pieces from one truck, feeding them into a hammer, and then placing them into another truck for shipment to an assembly department or to stock. This scheme eliminates at least two handlings that would be required if fixed stock bins were used at the machine instead of the trucks.





Besides carrying the supplies this portable stockroom serves as a convenient work bench when conduit must be threaded.

Materials and tools need not be checked in at night and they are on the job when the whistle blows in the morning.

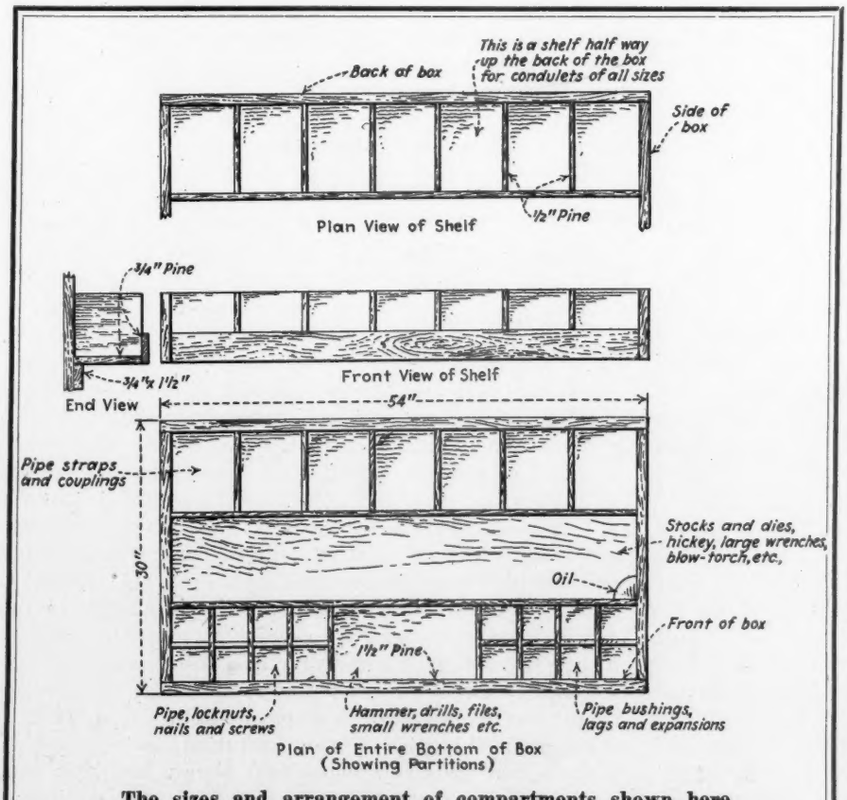
This Tool Box Saves Many Trips

to the Repair Shop and the Stock Room

N. S. DAVIS describes a portable tool box that he has found convenient in the electrical department of a large plant at Batavia, N. Y. When making changes and repairs in sections of the plant some distance from the repair shop or stockroom, this box eliminates guess work in things that will be needed and keeps the helper on the job.

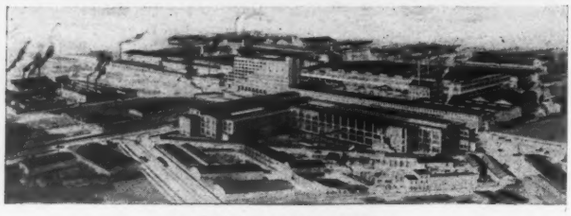
WHEN electrical repair work and changes are done on the job in an industrial plant a good deal of time is often wasted by men going back to get tools or supplies. In most cases the man doing the work cannot be blamed, for he usually leaves the shop loaded with as much as he can carry. Besides, it is sometimes impossible to tell what material will be needed until he is at the job doing the work. Furthermore, vises and tools for threading conduit cannot usually be carried by a man, and so it is necessary to go back to the shop to use them. There is, however, a way to save this time and these many steps. This way is to load the tools and supplies on a wheeled vehicle that can be pushed to the place where the work is done.

The portable supply box shown in the accompanying illustrations was devised for this purpose and has been found very handy in a large industrial plant at Batavia, N. Y. It consists of a strong box built on a four-wheeled factory truck. The box itself is made of 1½-in. pine wood and has a hinged door which hangs down when open. This door may be locked and the tool box left on the job over-night. (*Continued on page* 208.)


This is a shelf half way up the back of the box for conduiets of all sizes
Back of box
Side of box
½" Pine
Plan View of Shelf
¾" Pine
¾" x 1½"
Front View of Shelf
End View
54"
Pipe straps and couplings
30"
Stocks and dies, hickey, large wrenches, blow-torch, etc.
Oil
Front of box
1½" Pine
Pipe, locknuts, nails and screws
Hammer, drills, files, small wrenches etc.
Pipe bushings, lags and expansions
Plan of Entire Bottom of Box (Showing Partitions)

The sizes and arrangement of compartments shown here have been found convenient for the small supplies and tools carried in the portable box.

ELECTRICAL REVIEW AND INDUSTRIAL ENGINEER



DANIEL H. BRAYMER
Editorial Director

Assisted by
G. A. VAN BRUNT E. H. HUBERT F. E. GOODING

Chicago, April, 1922

You Should Be In Detroit April 26 to 28

IF YOU live within convenient reach of Detroit, Mich., you ought to be at the Hotel Statler April 26 to 28 and absorb the thinking of some twenty-three speakers who are listed on the program for the Spring convention of the Society of Industrial Engineers, as representatives of well-known organizations throughout the country. Although a considerable part of the program is devoted to management subjects, many of them have an operating slant, and Friday afternoon is entirely devoted to plant topics, with time provided for fifteen -minute papers by workmen and by managers and thirty minutes free-for-all discussion. Production costs is the main topic assigned for Friday evening. Another interesting feature that will be decidedly worth while is the schedule of inspection trips to twelve of the automobile and other large industrial works for which Detroit is famous.

Copies of the official program containing complete information about the meetings and the plant inspection trips can be obtained from the office of the Society at 327 South La Salle Street, Chicago. If you are responsible for a department in your works and you are not already a member of the Society of Industrial Engineers, you should be. The Detroit meeting will give you an opportunity to see just what it offers. You need not be a member to attend, for a cordial invitation has been given to industrial executives, assistants, foremen, factory employees, engineers and others interested in the prosperity of American industry.

Two Jumps Ahead of the Job

A WELL-KNOWN man recently ascribed his rise to a position of high authority to the fact that he "always kept two jumps ahead of the job." Success is something which can hardly be reduced to a rule or a formula, but this statement is worth thinking about. For faithfulness alone has seldom won recognition in a big way and mere performance of tasks assigned will not necessarily be sufficient to win promotion to the job ahead. Too much dependence on these qualities may bring disappointment when it is just a little too late.

Every piece of equipment, every process and method is susceptible of improvement. No matter how simple a task is, the chances are that the manner of performing it can be improved if enough time and thought are put on it. Keeping ahead of the job requires constant study and effort. It means learning as much as possible about the work in hand, and its relation to the activities of the organization as a whole. It means planning ahead, foreseeing probable emergencies or unusual conditions and being ready to meet them. In brief, it means using the mind as well as the hands.

When Apparatus Is Foolproof

SUCH general use has been made of the term "fool-proof" in connection with electrical apparatus that the real meaning is frequently lost. From the standpoint of accidental contact with live parts, all electrical apparatus used outside of a substation and generator room is proof against all except meddlers and tinkerers. When they are equipped with a hammer and cold chisel the term "fool-proof" has little meaning in any case. Two of the best examples of electrical apparatus that has done much to dispel fear from the minds of workmen who operate electrical apparatus, is the "safety" knife switch cabinet and push buttons for starting and stopping motors. For such equipment as this a better term than "fool-proof" would be "it's-safe", for after all an electrical device is "fool-proof" in its accepted sense, when it is built so that it can be safely operated by those who know nothing about the mechanism or the forces it may control. Knowledge that a device is built safe begets the same kind of confidence in a workman that a small boy gets from trying the spring of a board across a stream on a fishing trip.

Cement Mill as Training School For Repairmen

CARBON brushes have presented an operating problem to the maintenance man since the time they were first used on a commutator. But many of the causes of brush troubles he has laid at the door of the brush manufacturer have originated from improper application and careless adjustment. While a careful selection of brushes is important from the standpoints of uniformity of quality and their characteristics, such as hardness, abrasiveness, specific resistance, contact drop, coefficient of friction and thermal conductivity and the like, even brushes which satisfy rigid specifications on these points when improperly adjusted will cause all sorts of operating pranks to puzzle the repairman. In this issue some practical pointers are given for brush inspection and maintenance under the severe conditions of operation in a cement mill. Here eternal vigilance is the price of good operation, and the maintenance man gets experience that shows just how important it is to watch details and use care and judgment in inspection and repair work in order to keep his temper and his job.

Let's Have Your Ideas on Mounting Motors

INDUSTRIAL engineers are frequently confronted with the problem of adapting the individual motor drive to machines previously run in groups. There is a surprising field for ingenious and economical work here, and few whose attention has not been called to it realize the variety of motor mountings which have been developed by "home talent," so to speak. Designers of machine-motor units are sometimes prone to criticize these local adaptations as makeshifts. They point to their lack of symmetry, to their use of home-made strap iron, angles and brackets and contrast the efficiency of a self-contained unit with that of the perhaps awkward-looking geared or belted application to the existing machine.

The industrial engineer who carefully investigates problems of this kind and reaches the decision that under the circumstances it will pay to try out electrification of the old equipment need not hesitate a moment to adopt this course. Motor adaptations to old tools and machines often put new production life into the remaining years of service the equipment faces, besides increasing the quantity and quality of production. Any experimenting that will establish this fact or bring out improvements in applying motors to old types of machines under different service conditions will bear its fruit for all interested in the extension of electric service in plants that are not strictly modern in layout or design.

When additional equipment is required, information will be available to decide with some certainty on the most satisfactory new design. Under such circumstances the industrial engineer performs a real service that not only improves plant operation and economy but constitutes a real saving in the plant capital account. Machine designers can learn much if they will form such practical ideas of the operating man. We welcome ideas of this sort for publication.

Making the Haste That Means Waste

AN armature is rewound or equipment is repaired for the purpose of putting it into serviceable shape again—not in order to see how quickly the work can be done. It is well to bear this fact in mind inasmuch as there is sometimes a tendency, laudable enough in principle, to see how fast repair work can be gotten out. The desire or ability to perform a large amount of work is a fault rather than a virtue when the speed of accomplishment is so great that the quality of the results is below the proper standard. Repair work which is not thoroughly done not only means that the part in question will probably be unreliable in its performance, but that whatever saving was made by skimping on the job in the first place will be lost, perhaps several times over, by the delay and expense which a second failure will entail.

Time spent in doing a repair job well is never wasted; for that matter the same thing is true of any other kind of work, and applies to the preparations which may be necessary as well as to the performance of the work itself. For example, an armature winder who strips an old armature without first carefully noting the essential details of the winding, commutator connections and so on, is simply making the kind of haste that means waste.

There is no real saving in slighting the installation or neglecting any of the many details which are essential to a workmanlike job; the payment for a satisfactory job is merely being deferred. A certain reasonably definite time is required to do any particular piece of work well, and any attempt to shorten the time very markedly by cutting corners is very likely to be false economy. In emergencies it is sometimes necessary to do things in the shortest possible manner, but under ordinary conditions, the best way to save time and money is to spend enough of them to secure results which are known in the beginning to be possible and right in every respect.

What Is Your Inventory Value?

PRACTICALLY every business organization, regardless of its size, sets apart one or more periods in the year for taking an inventory of stock and for balancing up the books. This is the only method by which the management can determine the financial condition of the organization, find out whether progress has been made and intelligently shape the policies for the future.

Those of us whose stock-in-trade is less tangible than motors or umbrellas and who have to sell only the skill of our hands or the products of our minds, will find it profitable to follow once in a while the example of the merchant and go over our wares carefully. It may or may not be a pleasurable proceeding, but if we have the courage to do the job honestly and use the results that are found skillfully and conscientiously, the time will be well spent.

A few simple questions will serve to start the investigation. For example, one may ask himself: Am I keeping my stock of ideas fresh and adding to it through constant acquisition of new information? Or am I trying to sell only goods that have been on the shelves so long that they are shopworn? In other words, did my education stop when I left school or when I secured the position I now hold, or am I learning something new and useful every day? Am I studying myself fairly with the idea of finding a remedy for any weakness in this respect? Am I a better workman than I was one year, or five years ago, and am I really making progress in my chosen line? Are the jobs assigned to me constantly increasing in number and importance? If not, how can I make a closer application to my work and a more convincing demonstration of my ability to handle difficult problems? Do I know merely my own work or have I a sufficiently broad knowledge of the business as a whole to hold a more responsible position in case it should be given to me?

Simple questions, yes—but the ability to answer them as they should be answered may mean the difference between a job and a position and the contents of the pay envelope that usually go with these two classifications of work.

What Information Do You Need Most—

Shall We Have a Question and Answer Department?

A NUMBER of suggestions have been made in response to my invitation to comment on the subjects which the editors have outlined for future articles. Several have asked for a "Question and Answer" department. Others have mentioned a variety of practical problems that fall under one or the other of the fifteen general topics of articles to come as published in last month's issue.

Now, more than once, I have heard the editors say that this paper is going to be built on the desires of its readers rather than upon the thinking of those who may be in charge of the paper editorially. And I know that they are trying hard to search out the desires of readers and see that they are carried out. Right here you and I have a very definite responsibility. We must get down to a practical analysis of our own problems and make known the information that is most needed. As Sponsor for the Average Reader in a group that now numbers approximately twelve thousand engaged in a wide variety of work, I find it growing more important all the time to study the details of their jobs. I want your personal ideas and suggestions on your own work, the troubles you meet, the ways you have solved them and the knotty problems you are now working on. You have done this pretty well already by sending in practical experiences for publication, but go a step further. Comment on the schemes used by the other fellow as published and go him one better if you can, by telling how you have done the job in a different way and how it worked. Let's get to be a great big family corresponding with each other through the practical departments of *our* paper, for that's what the editors say it is and I know they mean it.

Now, a "Question and Answer" department appeals to me. If you want it, come on with your questions. If they are of the right kind and you show you are ready to help make such a department, I will do my best to put it across with the editors. Send in your questions and next month I will tell you whether or not we get the department.

Practical Pete

I am very much pleased with the Electrical Review and Industrial Engineer. The only suggestion I can offer is the adoption of a "Question and Answer" department where readers may ask each other for help in solving their individual problems.

Terre Haute, Ind. John T. Came.

* * *

One thing I would like to see in your new publication is a "Question and Answer" department where questions are answered by readers of the paper. We all have problems at times in which one little point made clear would help a great deal. By having your readers answer the questions, I believe a great many contributions would be secured

from men who would never start writing for a publication in any other way.
Belleville, Ont., Can. J. H. Gallant.

* * *

I have read Electrical Review for about ten years and wish to state that I wanted just the articles which are now appearing. May I suggest that you establish a "Question and Answer" column dealing with all practical work?
U. S. S. Pope. Fred Hauck.

* * *

I am interested in your new magazine and hope you will take up the mechanical as well as the electrical end of the maintenance man's work. In what follows I offer a few suggestions which would appeal to my squad here:

Portable Tools.—Portable Electric tools are beginning to be an important item in shop costs and an article on inspection and maintenance costs in comparison with compressed air tools would be of interest. Also the testing and repairing should be handled differently than it has been in preceding articles. For instance, the writer should start with a standard tool, tell why he used it and how. When testing the same, he should describe his work in detail as he went along, instead of giving a lot of general rules that would apply to different machines. Take a grinder, for instance, that had the starting coils burned out, explain the testing, make a sketch of the coils and the winding and explain whether or not it makes any difference if you wind the coils from right to left or left to right, how to connect, etc. Take a different type of machine each month, both a. c., then d. c., and you will find the average man will understand it much easier.

Motor Drive.—Articles dealing with the type of motor that should be used on different machines and why.

Power Factor.—Now that Public Service Companies are charging according to the power factor of the load, an article on alternating current installations with a low power factor and what can be done to improve it would be of interest.

Testing.—An article on keeping the plant in good condition, explaining what instruments are needed. By that I mean only those actually needed, as it is hard to convince the average manager that his man needs any at all. You should assume a plant with both alternating current and direct current motors from 1 hp. to 100 hp., and explain how to use them and what results you should get and the results of actual test under different conditions of the bearing and air gap, etc.

Welding.—Articles on different electric welding outfits with costs, compared with gas torches would be of value.

Heating.—There are many places, such as cabs for cranes, derricks, etc., to heat, and a table showing the watts per cubic foot required, something similar to the tables used for steam heat, would be a great help.

Belts.—A test on rubber, leather, canvas or woven belts against gear and link belt drive would be useful if taken by someone beside the maker.

Discussion.—If you would call for letters on various subjects, limited to so many words, a different subject each month, giving about a month's notice, then printing, say, three or four of the best offered, it would be a good chance to find out how the other fellow does it.
Worcester, Mass. Adam S. Mill.

* * *

I am personally very much interested in articles on new installations of power equipment and lighting, also on the repairs and maintenance of same. I believe a department that would be of particular interest to many plant engineers would be one devoted to electric welding, and also one to electric furnaces. I have not found a whole lot of every-day practical matter published on either of these subjects.
Swissvale, Pa. F. W. McGraw.

* * *

I will try in the near future to submit my experiences with the installation and operation of electrical and mechanical apparatus and I shall be interested in reading the experiences of other engineers along these lines.

1. Generator and motor operation, winding, banding, repairing, brush troubles and remedies, commutator turning and grinding, cleaning and painting machines with air, bearings and insulating materials.
2. Starting apparatus and control, protecting auto-starter (safety), privmary fuses, and relay switches.
3. Installing cables in subways and shafts, method of supporting, splicing, pot heads, locating trouble, kind of cables, voltage and life under different conditions.
4. Mine locomotives, types, repair part cost of operating.
5. Signal systems.

Bisbee, Ariz. W. R. Gibson.

* * *

Following your invitation for suggestions, I would like to make these:

1. Why not give to your readers a sort of consulting service—that is, devote one section to the questions of readers in difficulty, and then the answers or solutions given by your staff or perhaps offered by other readers.
2. In another section take up such problems as arise when standard equipment is at hand, but is not quite suitable to the application and then show how this standard equipment can be made suitable economically. Subjects like these: (a) Enclosing an open motor to keep out dust but still keeping down the operating temperature. (b) Adapting a standard motor when tipped at such angles as might interfere with lubrication.
3. Devote space to a series of articles on the selection and adaptation of electric motors—and other devices also—to the particular job at hand. In the last ten years I have been unable to find any really good book or literature on this subject.
4. The selection of controls for various purposes is often as important as the selection of the motor.
5. The matter of interconnection of controls, for purposes of safety or sequence of operation, is not generally understood; and is a simple and easily described subject.
6. A series of articles covering the development and present practice in skip hoist motors and controls would be found highly interesting. So would "car hauls," "car dumpers," "car pullers," "cableway hoist machines," "electric hoists—portable type," "material handling equipments" both stationary and portable, "electric locomotive cranes," hoisting towers and steeple towers," "bridge tramways" and innumerable other such subjects—subjects which are claiming the attention of central station men as well as of buyers and users of motors.
7. Local power distribution, plant layouts, etc., has not been covered in the way long distance transmission has, yet it is of vital immediate interest to a larger number of people.
8. Current collection by portable electric machinery should be exploited in efforts to bring out more satisfactory and economical methods of, for instance, bringing current to a locomotive crane.

Pardon these rambling notes, but the field is so large and so virgin that I am carried away by its possibilities and am only sorry that I cannot devote more time to it.
Chicago, Ill. H. T. Nafziger.

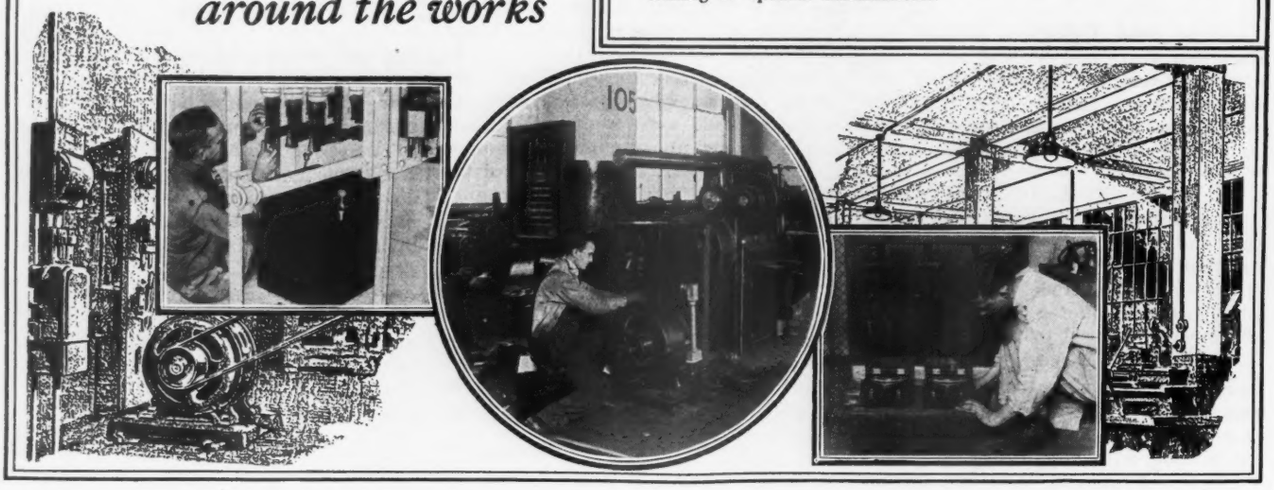
* * *

Since you have asked for my ideas it has occurred to me that some attention might be given to a series of articles dealing with costs and particularly the proper apportionment of power costs over the various processes and in the numerous departments. We have experienced considerable difficulty in arriving at accurate power costs, this having been emphasized of late, as we find it necessary with business as it is to estimate our costs before taking an order. Such estimates cannot be made dependable unless accurate data is available. Of course, meters cannot be installed on every machine so that some other method must be used. We are now engaged in this undertaking, but at this time do not know if a satisfactory scheme can be evolved.

Performance data of various machines is very valuable to an operating man as well as details of construction.
Syracuse, N. Y. Edward T. Moore.

SERVICE
around the works

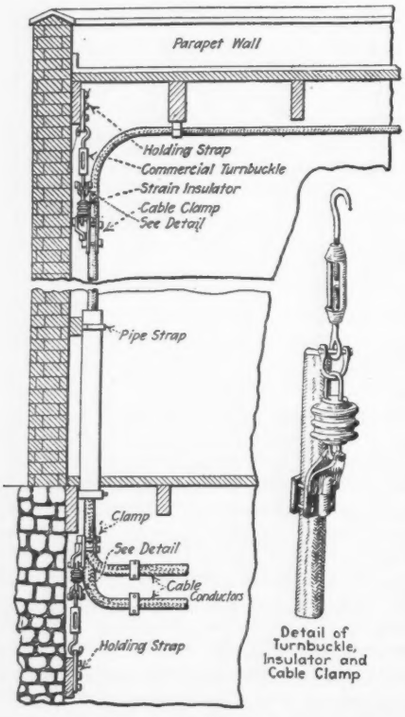
For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.



Vertical Cables Held Taut by Turnbuckles

BY USING turnbuckles and cable clamps, several 500,000 circ. mil cables which run vertically through several stories of an industrial plant are held taut. Strain insulators are inserted to provide insulation at the dead ends, and wrought-iron conduit tubes protect the cables from mechanical injury where they pass through the floors. This system obviates the use of copper buses, which usually require a shaft and take up more space.

St. Louis, Mo. RAYMOND H. WEAVER.



The cables are protected by means of wrought-iron conduit where they pass through the floors. A special strap holds the turnbuckles in position.

Determining Fuse Size for Mercury-Arc Rectifier

ON ACCOUNT of the high starting current required by mercury-arc rectifiers, trouble is sometimes experienced in determining the correct size of fuse to use. If the rating is too high, the tube will not be adequately protected against overloads and its life will consequently be shortened. On the other hand, if the fuse is rated too low, there will be a tendency to blow if the tube is cold and requires a greater amount of current.

The author has found that if the fuse is rated at the value obtained by the use of the following formula, proper protection will be had: $I=(1.5\times W)\div E\times\%\times P.F.$, where I= ampere rating of fuse, W=direct-current output of rectifier in watts, %=rectifier efficiency expressed as a decimal, P. F.= power factor of outfit, and E=voltage of the alternating-current energy.

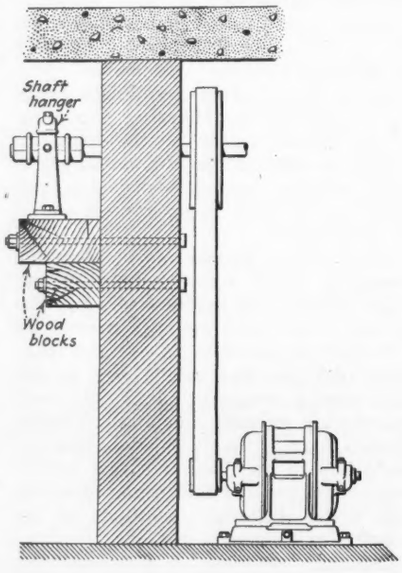
The rectifier efficiency is usually between 0.40 and 0.50 and the power factor is 0.90 in most cases. Where high reactance is used to smooth out pulsations, however, the power factor will be about 0.75.

H. E. WEIGHTMAN.

Chicago, Ill.

A Way to Use a Belt Drive Near a Wall

WHEN it is necessary to mount a motor so that its pulley is close to a wall there is usually encountered the difficulty of an allowance for the space taken up by the first hanger on the overhead shaft. When space is available on the other side of the wall and that side is not out of doors, such a situation can be overcome by the construction shown in the accompanying illustration.



This construction solved a motor drive problem in a tight place

The blocking for the end hanger can be securely bolted to form a support thus allowing the driven pulley to be

set close to the wall above the motor. This arrangement is in satisfactory operation in a foundry rolling room in New Britain, Conn.

New Britain, Conn. H. S. RICH.

Supports for Light and Power Wiring on Angle Irons

ON OVERHEAD angle-iron chords, braces and trusses open wiring may be supported neatly and securely by using seven-eighths inch boards, either in short or long lengths, when fastened in place with short bent-iron straps carried up over the edges of the angle-iron as shown in the accompanying sketches. The iron straps should be about 1 in. wide, ⅛ in. thick, and possibly 2 or 3 inches at the long end and 1½ inches long at the short end, with one or two holes for screws in the edge of the board. These boards should be the exact width of the angle-iron, and be planed on the lower, or exposed side.

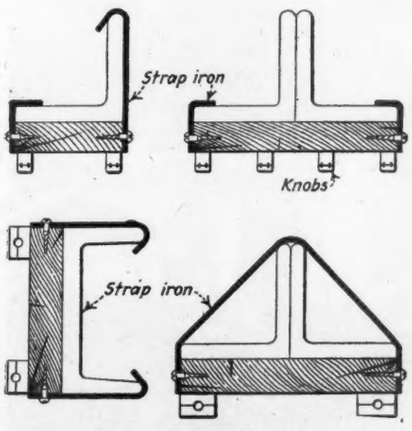
The wooden supports for the knobs may be carried all along the beam, and strapped every three feet or so; or sections about one foot long may be placed about four feet apart, securely fastened so they will not slip or slide when the wiring is drawn tightly.

This style of wooden support may be used on single angle-iron, double, and I-beams, for open wiring. It has been used in the core room of a large foundry where four slow-burning conductors were carried on one inch porcelain insulators with neat effect and at low cost for time and material.

For a line heavier than No. 14, the straps should be in one piece and carried up over the angle-iron where looks are not important. It greatly adds to the neat appearance of the job to have the boards painted before being installed. In many instances the iron straps may be bent into their final shape while the blocks are being held in place, or they may be bent first and then drawn down tightly when being screwed on.

H. S. RICH.

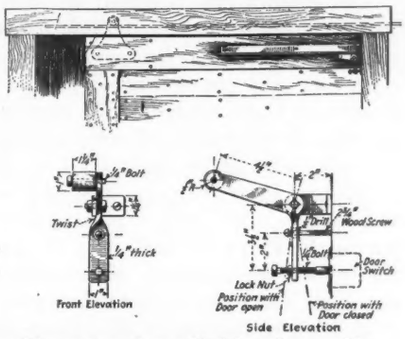
New Britain, Conn.



Four ways of supporting open wiring on steel construction.

Adapting a Swinging-Door Lamp Switch to a Sliding Door

SWINGING doors are easily connected up to automatic lighting switches operated by the opening or closing of the door. Ordinarily sliding doors are not as easily equipped because they do not always close so tightly. However, a sliding door to a storeroom at the Lane Manufacturing Company, Montpelier, Vt., has an attachment shown in the accompanying sketch, whereby the lighting circuit is controlled by opening and closing the sliding door. Use is made of a standard automatic door switch by adding a simple attachment which consists of a bent lever of iron with a roller made from a piece of old shafting placed at one end; at the other end holes are made for a bolt and a wooden screw. Near the middle it is drilled to receive a short bolt which serves as a fulcrum. This rocker arm is attached to the door frame by a short bracket. A piece of angle iron on which the roller bears extends part way across the door. While the roller is bearing against the angle iron the door switch is compressed and the lighting circuit is open. After the door has been opened far enough to let a man in, however, the roller runs off the angle iron, the switch closes the circuit and lights up the lamps in the storeroom. As soon as the door is closed far enough for the angle iron to press down on the roller the light goes out.



Storeroom lamp lights when roller runs off angle iron, whether the sliding door is closed tight or not.

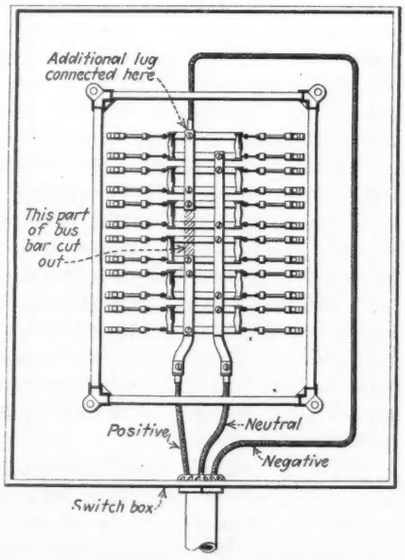
CLAYTON J. DEMERITT.

Montpelier, Vt.

Panel Board Easily Changed from Two-Wire to Three-Wire Distribution

SOME months ago, the writer was consulted in connection with changing the wiring of a building from the two-wire to the three-wire system. The building was previously supplied with 110-volt service and it had practically been decided to put in new feeders and panel boards, so as to connect with a new power plant which furnished alternating current, with 120-240-volt secondaries for lighting. The building itself was not of sufficient value to warrant any considerable expenditure for new equipment such as the new feeders and panel boards would require, and it was desired to provide service for the building at a minimum cost. It was found not practicable to provide a special transformer to feed this building separately from the others or to connect its load to one side of the three-wire system, on account of the unbalance which would frequently result.

Upon investigation, it was found that a third wire of one-fourth the current-carrying capacity of the present feeders could be pulled into the conduit without disturbing the wires to the existing panel boards.



Two-wire panel board changed to three-wire by cutting one bus-bar and running an additional wire as the neutral.

This was done and the panel boards were readily converted for connection to the three-wire feeders by cutting out a section of one of the copper busbars and providing one additional lug connection as shown in the diagram.

So far as the service for the building is concerned, this arrangement is just as efficient and reliable as the expensive change which was at first contemplated. The very simplicity of the arrangement was probably the cause of its being overlooked at first.

WILLIAM S. JONES.

Bureau of Docks and Yards,
Navy Department,
Washington, D. C.

Mounting Motors and Starters on Ceiling of Reinforced Concrete Building

THE photograph shows the method which an Eastern factory uses in mounting Westinghouse type "A" auto starters and induction motors on the ceilings of a reinforced concrete building. The ceilings are provided with inserts on 3 ft. 4 in. centers, taking a ¾-in. bolt head.

The starters are mounted on ½ in. by 2 in. steel straps drilled and tapped for ½-in. bolts for mounting a starter on one side and ¼-in. machine screws for mounting a Square "D" safety switch on the opposite side. These straps are bolted to the sides of 6-in. channels and have a piece of ½ in. by 1½ in. steel bolted across the bottom and extended 2 in. on the operating-handle side of the starter. A ¼ in. by 1½ in. brace is bolted at the bottom to this cross piece and at the top to the opposite side of the channel iron. This makes the mounting very rigid and prevents any movement when the starter is being operated. On 20/30-hp. starter equipment a No. 56343 100-ampere Square "D" switch is mounted on supports at the rear of starter. On 10/15-hp. starter equipment, a No. 56342 60-ampere Square "D" switch is similarly mounted. These switches protect the starter as well as make it easy for the repair man to cut off power from the starter when making inspections and repairs.

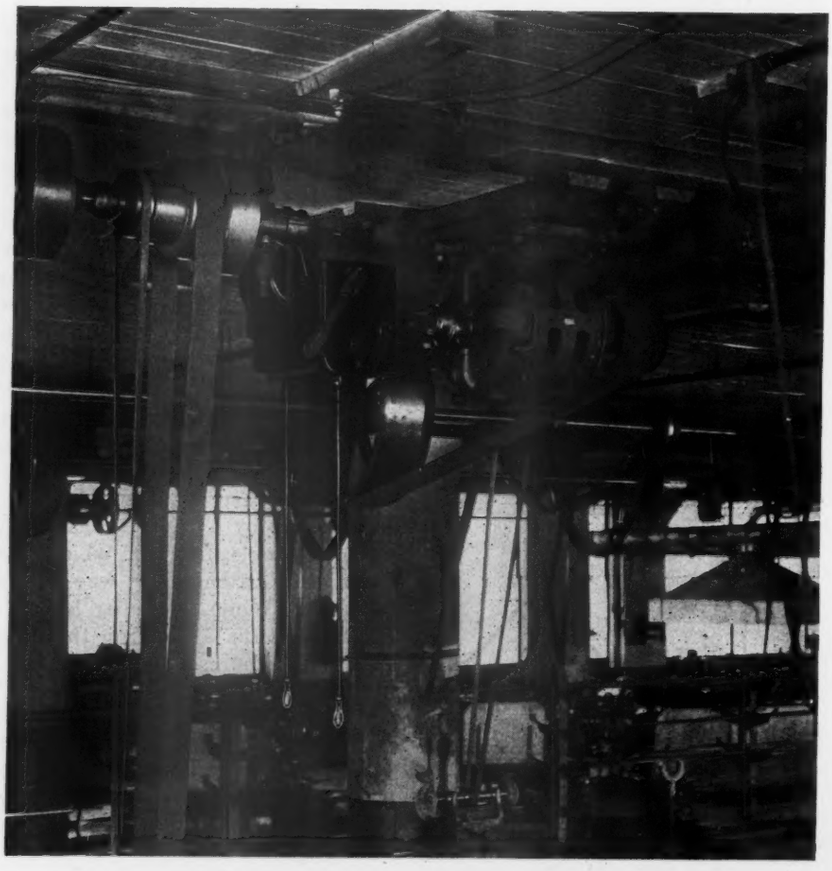
The 6-in. channel irons are made up in the shop and are all drilled and tapped for mounting two starters and switches, but usually only one starter is installed, except in cases where two motors are mounted close together. All of the ½ in. by 2 in. mounting straps are drilled and tapped to take both sizes of starters and switches, and are also used for mounting No. 6361 Square "D" motor starting switches, which are used on all 3-phase motors, up to and including 7½-hp., mounted on the ceiling.

The regular operating handles were removed from the starters and switches and a cast-iron rocker arm 11 in. long, with a hole in each end to which is fastened sash chain with heavy wooden file handles, was attached for operating the starters. The handles are marked to show which one to use for starting and for stopping the motor.

The motors are mounted on slide rails bolted to 6-in. channel irons which are in turn fastened to two pieces of 6-in. channel iron bolted to inserts at right angles to the motor; so there is no danger of motor hangers working out of inserts.

All feed lines are run in conduit to the switch, and switch and starter connections are in conduit. If the motor is more than 2 ft. from starter the leads are run in conduit; if it is 2 ft. or less, the leads are run open from starter to motor.

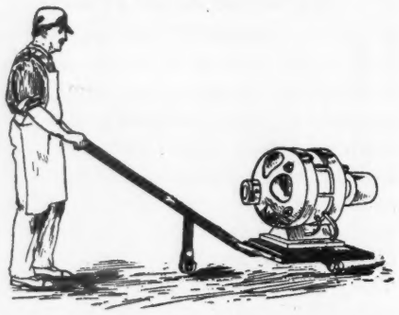
Swissvale, Pa. F. W. MCGRAW.



Motors and starters mounted on reinforced concrete ceiling.

Simple and Quick Means of Shifting Motors

IN case of a motor breakdown, when it is desired to quickly bring a spare motor to the spot for replacement, the home-made dolly truck shown herewith has proved very useful. This truck consists of an 18-in. or 24-in. platform on rollers which can be moved by means of an iron handle bolted securely to the truck. The distance between the top of the platform and the floor is 3 in., the end being tapered off to a thickness of about ⅝ in., and covered with ⅛-in. sheet steel to facilitate sliding motors on or off.



Light-weight trucks handy in transporting motors in case of an emergency.

Load Survey Shows Whether Proper Size of Motor Is Being Used

IN THE plant of a large machine-tool manufacturer in New England it was decided to find out just how much load each motor was carrying and to shift or relieve of a portion of the load those which were too heavily burdened.

Suitable a. c. meters were purchased and readings taken from all the motors in the plant. The data were written up on log sheets, together with all of the name plate data. The log sheets were then numbered and indexed by the building number and floor. By this method if the location of the motor is known, all further details can be easily found.

At the time the test was made, the first, second, fourth and sixth columns were filled out. The figures in the other columns were found by calculation. The friction load includes only the friction of the motor, line shafting and belting.

SUMMARY OF THE RESULTS OF LOAD SURVEY

Number of motors tested	56
Number loaded up to 50 per cent of rated capacity	34
Number loaded 50-80 per cent of rated capacity	16
Number fully loaded	4
Number overloaded	2
Total rated horsepower	1,490
Average actual load, horsepower	744
Load factor, per cent	50

The two overloaded motors were both 20-hp. rated capacity. One of these was overloaded 60 per cent, but fortunately this motor was one of those old type C Westinghouse motors that were ruggedly built to withstand overloads. The survey also revealed 25-hp. motors carrying loads of 2 hp. to 6 hp. and 8 hp., and 50-hp. motors carrying 25 hp. It is evident that by changing some of these motors around, the proper motor could be applied to the different loads.

Such a record must be kept up to date, particularly when a motor is shifted. However, if such entries are not made, the plant electricians usually remember the former location of the motor; it can also be identified by its serial number.

Since there is a tendency in all factories to shift the machinery from place to place, it is necessary to check up periodically the loads on the motors. The frequency of these check-ups naturally depends on the number of such changes in the shop.

New Haven, Conn. HERBERT J. WOLF.

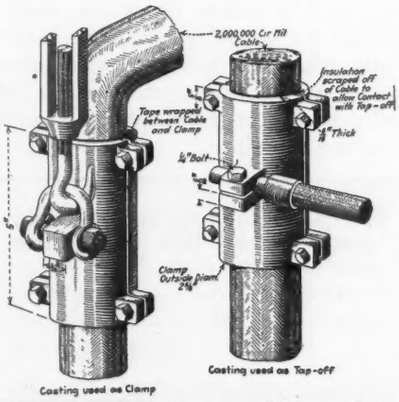
Data Sheet for Load Survey

Test on 20 h. p. motor, 2 phase, 200 volt, 1120 r. p. m., 60 cycles. Current transformer ratio = 10:1. Watt meter Const. = 1.

Time	Ammeter Reading Per Phase	Amperes per Phase	Voltmeter Reading, Volts	Apparent Power in Watts per Phase, ExI	Wattmeter Reading per Phase in K. W.	Actual Power in K. W. per Phase	Actual Power in H. P. per Phase	Total Power Taken by Motor in H. P.	Power Factor in %
Friction Load	2.0	20	216	4320	.27	2.7	3.62	7.24	62.5
1:25	2.6	26	216	5620	.46	4.6	6.16	12.32	81.8
1:30	3.2	32	216	6920	.55	5.5	7.37	14.74	79.5
1:35	3.2	32	216	6920	.56	5.6	7.50	15.00	81.0
2:15	2.9	29	216	6270	.52	5.2	6.97	13.94	83.0
2:18	2.8	28	216	6050	.47	4.7	6.30	12.60	77.7
2:20	2.5	25	216	5400	.39	3.9	5.22	10.44	72.2
3:00	3.1	31	216	6700	.52	5.2	7.00	14.00	77.6
3:30	2.8	28	216	6050	.49	4.9	6.56	13.12	81.0
4:05	2.5	25	216	5400	.37	3.7	4.95	9.90	68.5
4:30	2.5	25	216	5400	.41	4.1	5.49	10.98	76.0

Making a Cable Clamp and Tap-Off from the Same Castings

THE cable clamp and tap-off shown in the accompanying illustration were manufactured from castings made from the same pattern. The casting is sawed in two parts and four holes drilled in the side lugs so that the halves can be clamped around the cable. When the casting is to be used as a cable clamp a hole is drilled in the lugs at right angles to the cable axis. A bolt in this hole holds a "U"-bolt, which in turn holds a turnbuckle supported from the ceiling.


2,000,000 Cir Mil Cable
Insulation scraped off of Cable to allow Contact with Tap-off
Tape wrapped between Cable and Clamp
¼" Thick
½" Bolt
Clamp Outside Diam. 2½
Casting used as Clamp
Casting used as Tap-off

Because this bronze casting can be easily adapted to serve either as a cable clamp or a tap-off, construction work can be hastened.

When used as a tap-off a hole is drilled in the lug perpendicular to the cable axis to hold the lead terminal, but in addition the lug is split by a saw, as shown, so that it will clamp. The bottom half of the hole drilled in the lug is threaded so that the ¼-in. bolt can hold the lead conductor.

When a cable has to be held by one of these clamps it is taped so that the casting will not slip. When the casting is used as a tap-off, however, the cable insulation is removed so that a good contact will be obtained.

New York City. CHARLES E. SMITH.

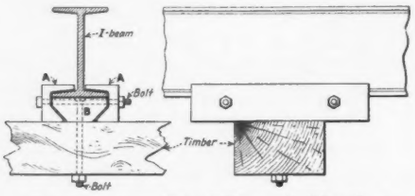
Steam Flange Union Used as Conduit Coupling in Cramped Space

IN THE course of some work which was being done it became necessary for us to break a 2-in. conduit between two large beams and in a very much out-of-reach corner. We were able to split the coupling with hack-saw and chisel and spread the ends of the conduit enough to pull out the wires, but could not remove the conduit to make a running thread or do any work on it. So the problem arose as to how we were to join the conduit ends after our work was completed. We finally put on a common steam flange union with four bolts and tightened three of them, but we could not reach the fourth. This made a very firm joint, although it is not particularly pleasing in appearance. It has never been inspected, but I think it would pass.

Batavia, N. Y. N. S. DAVIS.

Clamp for Supporting Motor from Ceiling I-Beam

FOR hanging motors from I-beams on the ceiling the method illustrated herewith is employed in the factory of McCleary, Wallin & Crouse, Amsterdam, N. Y. The motors are mounted on timbers



Clamp secured to I-beam holds timber which supports motor.

which are bolted to the cast-iron clamps. Each clamp has three parts. The parts of the clamp *A* and *A* are held on the center *B* with 1-in. bolts. The 1⅛-in. hole *H* in the center part of the clamp is counter-sunk on the bottom or I-beam side for the square head of a 1-in. bolt, which projects through the piece *B* and the timber, which is tightened against the clamp by means of a nut. This makes a satisfactory support which is quickly put up and taken down.

A. R. McDONALD.

Chief Electrician,
McCleary, Wallin & Crouse,
Amsterdam, N. Y.

Small A. C. Motor Mounted so That It Will Not Hum

RECENTLY the writer was called upon to mount a ¼-hp. alternating-current motor in such a way that it would not hum. After trying several methods of support quietness was at last secured by bolting the motor to flexible steel strips which rested on a concrete block as the drawing shows. The steel strips were of ⅛-in. x 1½-in. cold-rolled strap bent to form feet at each end. These feet rested in shallow recesses chiseled in the concrete block. The block was made fairly heavy, 4 in. thick, 10 in. wide and 18 in. long.

One end of the block rested on a 2-in. x 3-in. wooden cleat lagged to the wall. Two iron wires hung from the ceiling beams supported the outer end of the block. Inserted in each wire was a turnbuckle to allow exact adjustment of their length. Another wire was passed around the outer end of the block and attached to screw eyes in the wall. This held the block against the wall. After the feet were in place in the recesses in the block sulphur was poured around them. No other means was provided for securing the feet. This was sufficient because the strips were long compared with the height of the pulley above the block and because the pull of the belt was not above the horizontal.

With this mounting practically all noise was eliminated. The elastic strips and wire supports absorbed the vibrations which would cause humming if the motor was mounted solidly on rigid support.

Whitman, Mass. DEXTER W. ALLIS.

Causes and Methods of Remedying Ordinary Bearing Troubles

BEARING trouble, if detected and remedied promptly, is not serious except that on an important drive it may hold up production. Usually, however, bearing trouble develops rapidly after a certain stage is reached in its condition, after which serious troubles may develop.

Frequent causes of bearing trouble are dirt or grit in oil wells, excessively tight belts and sticking oil rings. In addition, if the end bells of small motors are not installed correctly, difficulty will arise on account of the shaft being out of line.

In dirty and gritty places it is almost impossible to keep the ordinary induction motor bearings clean. About the only solution for this condition is to inspect the boxes closely, drain the oil off at frequent intervals, clean out the well with kerosene, and fill with new oil. The old oil can be filtered and used on slower-moving machines.

In spite of good and regular treatment, the boxes are apt to heat between weekly inspections, but it is possible to clean the wells with kerosene and refill while the motor is in operation by draining the box and pouring in kerosene at the same time. In stubborn cases it may be necessary to add a heavier oil, but if this is done, care should be taken to change to light oil as soon as the box is cool. If this is neglected it may cause the oil ring to stick when the motor is started up cold. Some of the recent motors have the well covers screwed down, which makes for inconvenience of inspection, but helps in keeping out the dirt.

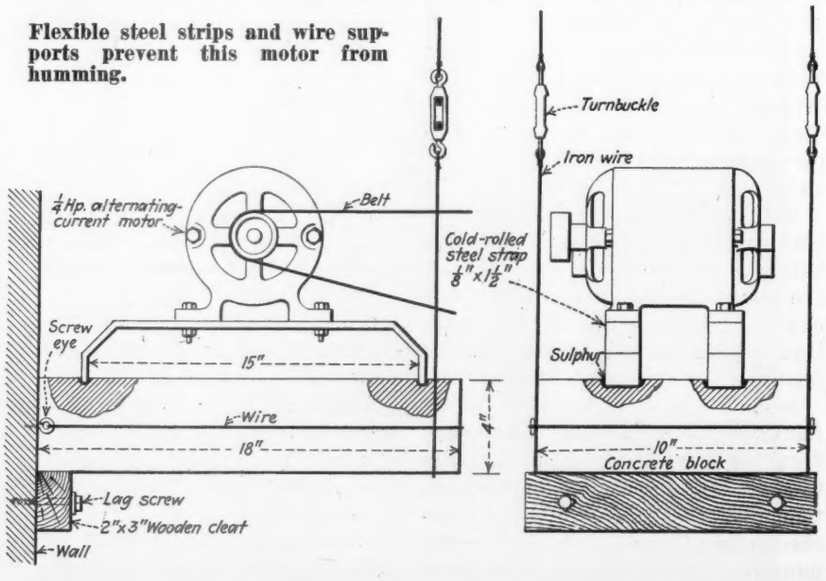
Tight belts and short vertical drives will cause bearing trouble. Where possible, belt drives should be horizontal and of reasonable length, with the pull on the bottom of the belt. This allows the sag of the belt to hug the smaller pulley more, thus giving a maximum contact surface which enables the belt to function properly with less deterioration.

In the case of oil rings sticking, the trouble is usually caused by the oil becoming foul and gummy—some new oil would have prevented this—or it may be that too heavy oil is being used. If the latter is the case, the oil ring will cause trouble soon after the motor is started, as the natural heat of the bearing will thin the oil while running. When cold it may stiffen so that it holds the ring. For this reason, every motor should be inspected before starting.

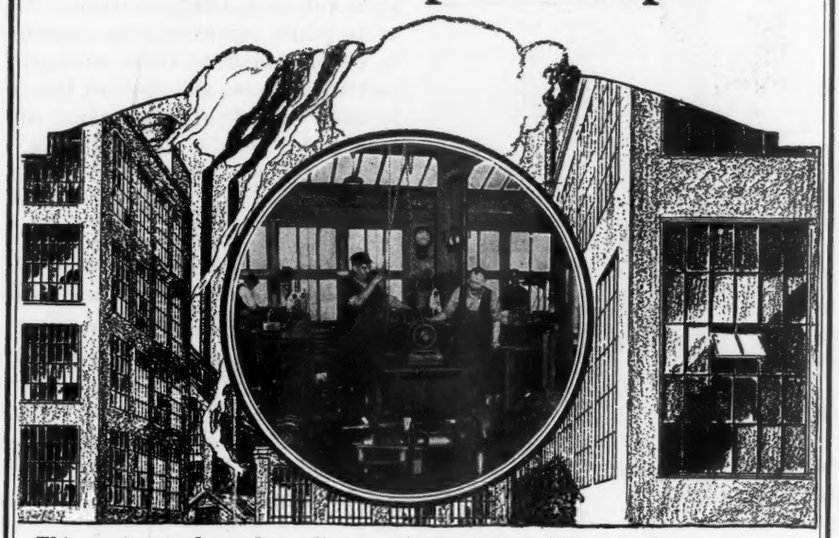
W. B. SMITH.

Aroostook Pulp and Paper Mill,
Van Buren, Maine.

Flexible steel strips and wire supports prevent this motor from humming.



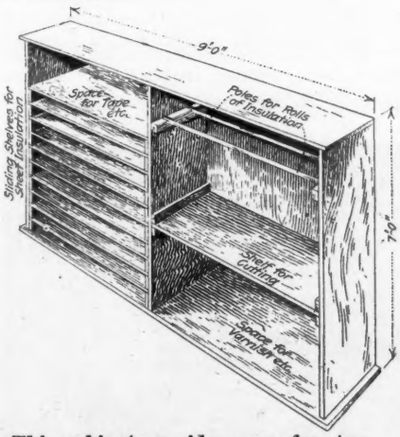
In the Repair Shop



This section is devoted to all sorts of electrical repair work, large and small. Special attention is given to tools found convenient at the shop bench and short cuts or improved methods. Articles on these subjects are always welcome.

Repair Man's Cabinet for Storing Insulating Material

A HANDY cabinet for storing insulating material has been constructed by the testing department of the Chicago Sanitary District. It is made of ¾-in. pine lumber. The main dimensions are: Length, 9 ft.; height, 7 ft.; depth, 5 ft. It is divided equally by an upright partition running back to front. Each half has a separate double door, not shown in the drawing, equipped with a lock. The left half has nine shelves about 5 in. apart, starting near the floor. These shelves slide out so that material such as sheet mica and stiff fiber may be handled without being bent or damaged.



This cabinet provides space for storing sheet and rolled insulations needed in the repair shop. The sliding shelves facilitate handling sheet insulation.

In the top compartment, which is about 20 in. high, is placed such material as tape, sleeving and washers. Labels are pasted inside the doors opposite each shelf as an index to what it contains. The right half has ledges on each side about 16 in. from the top, for round supporting bars, on which are placed rolls of fiber, varnished linen, and the like. Halfway from the floor is a shelf on which the material which is pulled down from the roll may be placed for cutting. This shelf also slides out. Beneath this shelf are stored varnish, paint, oil, and similar supplies for repair work.

Devices for safe and orderly storage give a character to a workshop. Perhaps the greatest advantage lies in the reduction of time which would ordinarily be wasted in looking for supplies where they are scattered about the shop.

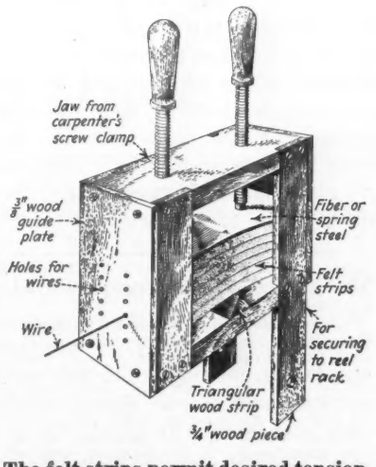
Tension Block That Will Not Injure the Insulation on Magnet Wire

WHEN winding enamel-covered magnet wire it is often difficult to apply tension to the wire without injuring the insulating covering. The same difficulty is encountered in only a lesser degree in winding either single or double-cotton-covered wire. A device that is giving satisfaction in daily use with both of these varieties of wire is easily and cheaply made from an ordinary carpenters' wooden screw clamp, as shown in the accompanying drawing. The friction blocks are made of felt, as shown in the accompanying illustration.

The clamp selected should have jaws about 1½ in. wide. The beveled ends of the jaws are cut off where the bevel starts, and the remaining portions of the jaws fastened together with four pieces of ¾-in. wood. The inside space between the two jaws is about 4¾ in. for ordinary work. Flat-head wood screws are used for fastening the various parts together. Guide plates, of ⅜-in. wood, with holes of a number, size and arrangement to suit the work in hand, are made for the front and rear of the device. The edges of the holes should be carefully smoothed and rounded with sandpaper.

A small strip of hard wood, triangular in cross section, is fastened crosswise to the middle of the lower jaw. The sides of the triangle are all ½ in. wide. Strips of solid, heavy felt, ½ in. thick, are cut to fit snugly between the side and end pieces as shown. As many strips are used as there are horizontal rows of holes in the guide plates. They are topped with a piece of light spring steel or ⅛-in. thick fiber. The screws bear on this top plate, and it will be found necessary to cut them off a bit in order that they will not project so far that they are clumsy for the operator to handle.

The wire is threaded through both guide plates and between the pieces of felt. Tension is applied and adjusted by means of the two screws and may be very closely regulated without injuring the insulation of



The felt strips permit desired tension on the wire without injury to the insulation.

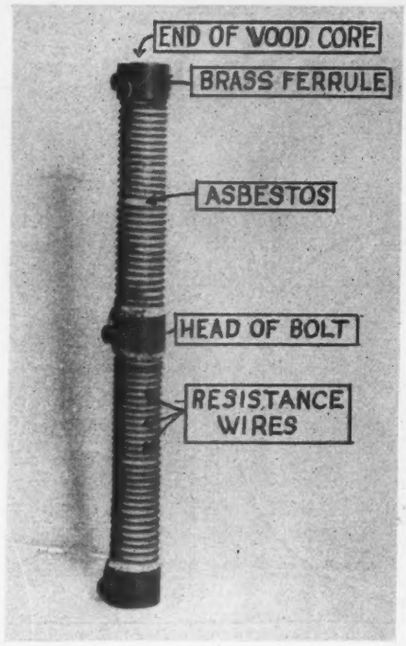
the wire. The projection of the side pieces on the back end affords a flexible means for attaching the device to the reel rack which holds the spools of wire. J. M. WALSH.

Gurney Elevator Co.,
Honesdale, Pa.

Special Tool Winds Resistance Units for Crane Motor Control Rheostats

RESISTANCE units for use in the control of crane motors are wound by the aid of a simple and inexpensive rig in the repair shop of the Gary Screw and Bolt Company at Gary, Ind. This winding device is built of wood and, as shown in one of the accompanying illustrations, consists of two cupped spindles supported on bearing blocks which are mounted on a wooden base fastened to the bench. One of the spindles is provided with a crank handle for turning the core while winding. A slot in this spindle cup engages a screw head on one end of the core and keeps the latter from slipping in the cup. The other spindle is movable and can be slid back for putting in or removing the cores. When a core is mounted for winding a slotted block is inserted between the bearing block and the cup end of the spindle and serves to keep the latter from sliding back and releasing the core.

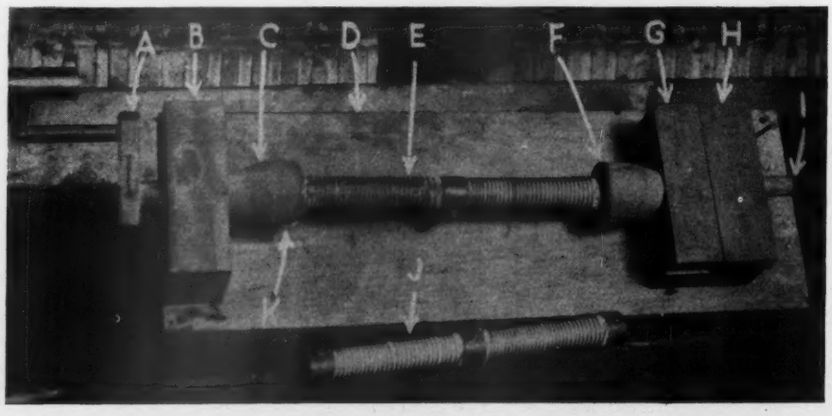
The resistance coils are made up on wooden cores about 11½ in. long by ⅝ in. in diameter, which are protected by a covering of sheet asbestos 3/16 in. thick. The cores are fitted with three brass ferrules, one at each end and one in the middle, to which the resistance wire is attached by the aid of round-headed machine screws fitting into tapped holes in the ferrules. With the three ferrules in place, five to seven layers of asbestos paper are applied to the core and glued down, bringing the diameter of the core with the asbestos in place up to 1 in. Then the core is placed between the two cupped ends of the winding block,



Resistance units like this can be mounted in fuse type clips and are quickly replaced.

the resistance wire is fastened to one of the end ferrules and wound tightly around the core, after which it is fastened under the screw heads on the ferrules at the middle and far end of the unit. The turns of resistance wire are equally spaced by passing a loop of wire around the core, holding this loop and the resistance wire in the left hand while turning the crank with the right hand. This loop, which is 14 in. to 18 in. long, lays between the turn just wound and the one being applied. The loop travels along as though the tube were threaded, spacing each oncoming turn just the diameter of the loop wire from the previous turn. Tension is kept on the resistance wire by passing it between a pair of wooden blocks drawn close together by two screws and clamped to the edge of the bench. Sometimes it will be found more convenient to obtain the desired tension on the wire by leading through a set of slots cut in a block of wood. The units when completed are inserted in clips, similar to those used with cartridge fuses, mounted on the resistance board of the crane controller. A. L. GEAR.

Chief Electrician,
Gary Screw and Bolt Company,
Gary, Ind.



This device makes it easy to wind resistance units.
A, crank for turning core to apply the wire. *B*, bearing block supporting the cupped spindle *C*. *D*, base of winding device. *E*, finished unit ready for removal. *F*, removable spindle which can be pushed back to release finished unit by removing slotted block *G*. *H*, bearing block for spindle *F*. *I*, projecting end of this spindle. *J*, finished unit removed from machine. *K*, head of ferrule screw engaged in slot in cup of spindle *C*.

Broken Armature Shafts Welded Without Removing Coils

LARGE armature shafts occasionally break at the junction of the journal and the pulley end. Where the armature coils can be separated from the fracture by a few inches of molding sand (at least 4 in. in the case of a 3-in. diameter shaft) a repair by the thermit welding method is entirely feasible without injuring them, if the following simple precautions are observed. The heat which is conducted along the shaft must be dissipated either by directing an air blast on the shaft or, where necessary, by means of a specially constructed water cooler box with packing box on the shaft to prevent the possibility of any water coming in contact with the windings. The windings themselves are further protected by being totally encased in an oilcloth and burlap bag. There is no danger of damaging the armature windings through the effect of direct heat, as the fracture is completely surrounded by molding sand and the heat incident to welding is shut off by it.

In case the keyway of the pulley end of an armature shaft becomes badly worn, this worn end can be removed and a new oversize extension welded on and machined down. A large number of such extensions have been welded in this way in the past with very satisfactory results.

As an example of costs, in the case of an oversize extension to 3½-in. diameter shaft, the welding was recently done for approximately $35, not including machining.

In the building up of worn keyways on pulley ends of armature shafts it is usually recommended that the old pulley extension be cut off and a new oversize extension be welded to replace it.

New York, N. Y. L. I. GRINNELL.

Localized Blower Improves Working Conditions

FUMES from melted resin and beeswax, which formerly annoyed workers at the Boston Repair Shop of the Western Electric Company, Inc., are now easily exhausted from the room by the 1/6-hp. motor-driven blower shown in the accompanying illustration. The blower, a Sturtevant "E-6" fan with 5-in. discharge duct, exhausting through a short duct leading outdoors, is directly connected to a 220-volt, single-phase motor running at 1,800 r.p.m.

Disagreeable fumes from material melted in this pot are exhausted through the metal hood.

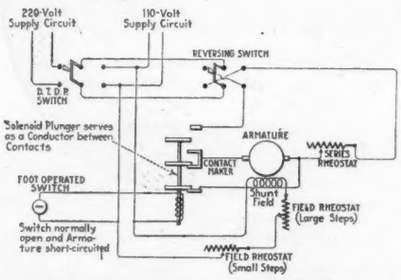
The fumes are collected by a 12-in. × 18-in. metal hood extending over the rear of the melting pot, which is electrically heated. The draft thus induced had a tendency to lower the temperature of the pot. For this reason, to insure steady flowing of the melted material which hardens quickly, a supplementary electric heating coil was applied to the discharge pipe just back of the faucet.

J. S. THOMAS.

Western Electric Company, Inc., Boston, Mass.

Varying Lathe Speed for Armature Repair Work

COMMUTATOR turning and grinding and coil winding can all be accomplished on an ordinary motor-driven speed lathe in the shop of the Naumer Electric Company, New York City, by using field rheostats and energy supplied at two voltages to obtain the desired spindle



Putting rheostats in shunt field and providing a double source of voltage allows speeds from zero to 500 r. p. m. both ways.

speed. The greatest difference of speed is obtained with the use of the 110-volt and 220-volt circuits; rheostats in the separately excited shunt field afford the intermediate steps in speed.

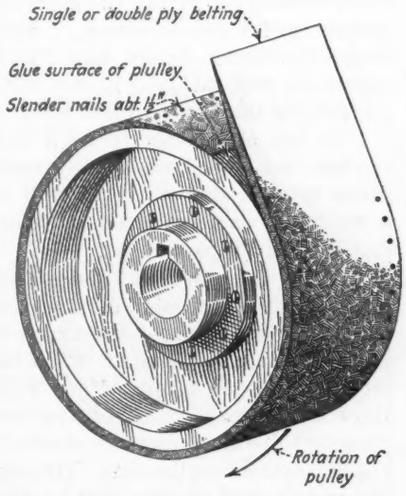
For grinding, a maximum speed of 500 r.p.m. is needed for good results, whereas for coil winding the speed must necessarily be low and in the opposite direction. This reversal is obtained by means of a switch which reverses the direction of current in the armature. For this work the armature must be started and stopped practically instantaneously, so a foot-operated contactor is used. The normal position of this contactor is such as to short-circuit the armature. Pressing the foot switch energizes the contactor, thereby removing the short circuit, allowing energy to flow to the armature. When other operations are performed this control is not needed, and the contactor is mechanically locked in the open position.

A Way to Change Pulley Speed Slightly

SOMETIMES when a motor does not drive its load at the required speed, the trouble can be traced to the pulley being a trifle too small in diameter. If a paper pulley is used this trouble can be easily remedied by tacking a strip of leather belting around its surface. To do this, first figure out the required diameter. Then determine if single or double ply belting should be used. The leather should first be cut to the full width of the pulley, and long enough to go around just once and allow the ends to overlap about three inches.

The ends should be pared down with a sharp iron plane to a thin beveled edge so that when they are lapped the thickness will be uniform with the rest of the belt. Fasten the first end with slender wire nails about one and one-half inches long placed not over one inch apart across the planed edge. Then the belting may be glued all the way around the pulley and nailed in many places, especially along its edges lengthwise. If no glue is used, many more small nails should be used to keep the leather from creeping. The last end should be fastened down carefully and tightly so that it will never work up or curl over.

The leather should be put on the pulley so that the last end runs with the driving belt it is to carry. In other words, wrap the leather around in a direction opposite to the direction that the pulley is to run. This will prevent air from getting under the last edge in case it does work or



Enlarging a wood or paper pulley with leather belting.

tear loose, and cause the edge to curl up under the driving belt. The writer has resorted to this scheme often to get the correct speed on a driven machine, sometimes using heavy double belting.

Such an application is usually only temporary as the friction of the driven belt is likely to cause some displacement in the leather on the pulley or the driving belt may get scratched or torn by some of the nails working out.

New Britain, Conn. H. S. RICH.

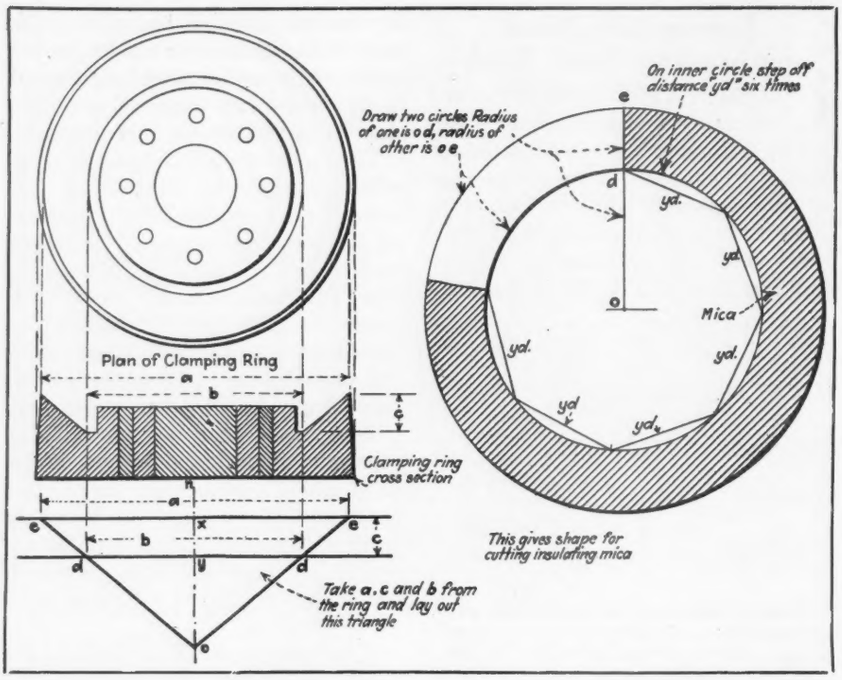

On inner circle step off distance yd" six times
Draw two circles Radius of one is o d, radius of other is o e
Plan of Clamping Ring
Clamping ring cross section
Mica
This gives shape for cutting insulating mica
Take a. c and b from the ring and lay out this triangle

Diagram showing how to lay out shape of mica for commutator clamping ring.

How to Cut Mica Right Shape for Insulating Commutator Clamping Ring

WHEN re-insulating commutator clamping rings there is sometimes trouble in cutting the mica insulation to the correct shape. I have drawn the sketch shown here which shows the method used in our shop for getting the proper dimensions.

I do not claim this to be a new method but I believe that it will prove to be a time saver as well as a means of saving insulating material in many repair shops.

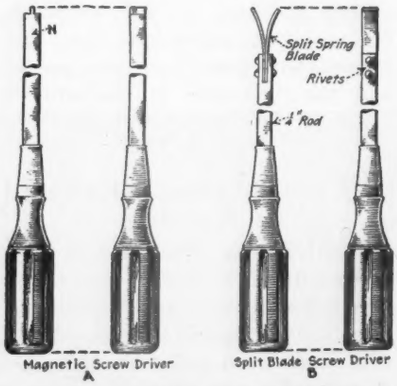
To use this method, first determine the perpendicular distance between the small end of the ring and the large end, indicated at "c" in the left-hand part of the drawing. Then draw on a piece of paper two parallel lines "c" distance apart as shown in the triangle below the ring. Through the middle of these lines draw a perpendicular line "no." Then measure the diameter of the large end of the ring, as at "a," and the small end at "b." Transfer these measurements to the parallel lines as shown in the triangle. Two lines drawn through these four points "ed" and "cd" should intersect the perpendicular line "no" at point "o." Then "od" is the radius of the small circle used in laying out the shape for the mica and "oe" is the radius of the large circle. Describe these two circles with the same center as shown at the right. Then with dividers take from the triangle the distance "yd" and step off six spaces on the smaller circle. Lay a rule with its edge passing through the starting point and the center of the circles. Make a mark along this rule from one circle to the other. This will be one end of the mica strip. For the other end lay the rule from the center to the finishing point on the circle and work from one circle to the other along the rule.

C. G. PIERCE.

Electrical Engineering & Construction Co., Des Moines, Iowa.

Magnetic and Split-Blade Screwdrivers for Small Repair Work

IN DOING small repair work on electrical apparatus, cases arise where the workman cannot insert a screw with his hand. Two screwdrivers, for large and small screws,



These magnetic and split-blade screwdrivers are useful when inserting small screws in close places where the workman cannot reach with his hands.

respectively, have been developed for use where this difficulty arises. The former (*A*) has a short shank and is magnetized, and the latter (*B*) consists of a split-spring blade, attached to a ¼-in. rod mounted in a screwdriver handle. To use the screwdriver the two springs are sprung together and inserted in the screw slot. Their tendency to spring outward grips the screw and holds it until it can be started. A heavier screwdriver can be used for tightening if necessary.

Poor Brush Contact Seriously Affected Speed of Direct-Current Motor

THE necessity of obtaining as perfect a contact as possible between the brushes and commutator of a direct-current motor was illustrated recently by the following experience of a motor manufacturer.

Excessive speed drop on full load was reported on a motor which had left the test floor in first class condition. The motor was of the interpole type, rated 15 hp., 230 volts. Investigation revealed the fact that the commutator had been turned and ground just before the trouble began. The brushes had apparently been well seated, but the speed fell off so that the regulation on full load was more than 11 per cent. In attempting to remedy this condition, the electrician in charge had, in the meantime, shimmed down the interpoles until the regulation was about 8 per cent.

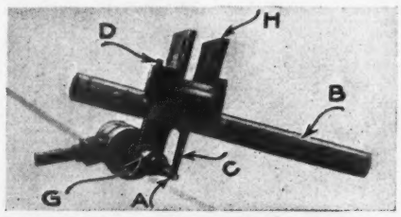
It was observed, however, that the surface of the commutator did not look smooth or polished. There were evidences of poor grinding in abundance, but these had apparently been overlooked. A commutator-smoothing stone was lightly applied to the commutator, the brushes cleaned and the commutator wiped with a clean cloth. When the load was applied after this, the motor hunted or pumped in consequence of the overstrong interpole field; the armature no longer had the high resistance of the poor brush contact in series with it to damp out the hunting. When the shims were removed from under the interpoles, restoring the interpole field to its original strength, the motor operated satisfactorily on all loads.

Honesdale, Pa. J. M. WALSH.

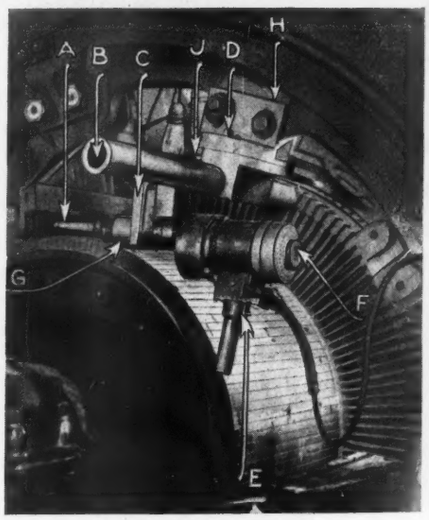
Slotting Machine for Undercutting Mica on Commutators

FOR undercutting mica on commutators, the mechanical department of a large electrolytic plant in Canada has developed and built an efficient machine. This undercutter is made of an electric drill mounted so as to be movable along the length of the slot and adjustable to be parallel with the slot.

For mounting this machine, it is necessary to remove one of the brush arms, in place of which are clamped the jaws *H*. On these clamp pieces is mounted a base plate which may be revolved to bring the cutter in line with the commutator slot by loosening the cap screw *D* and swinging the hollow steel tube *B* to either the right or the left. This tube is fitted in the base and can be held in any position, depending upon the length of the commutator. This is accomplished with the tightening screw *J*, which draws a tightening block up against the top of the outside of the steel tube, as shown in the end-view drawing. A cylindrical brass slipper is fitted in this cylinder so that it may slide, and to this is fastened by a tapered steel pin the plate *C*, which passes through a 5/8-in. slot in the tube, permitting this plate *C* to be slid up and down the length of the tube. A sleeve *G* is fitted into this plate for holding the shaft *A*. A long spindle holding the cutting tool is substituted for the chuck of the drill. In order that the cutting tool may be lifted out of the slot and also that the depth of the cut may be varied, the shaft is slightly off center with the spindle which drives the cutting tool.



Parts of commutator slotting tool shown in drawing below.



Tool mounted on brush rigging for slotting commutators

For the cutting tool a miller 0.75 in. in diameter and 0.030 in. thick with thirty-two teeth has given the best results. The cutter is driven at approximately 1,650 r.p.m and should be about 0.0005 in. wider than the mica to remove it completely. The cutting edge should revolve in a direction toward the operator while cutting the mica.

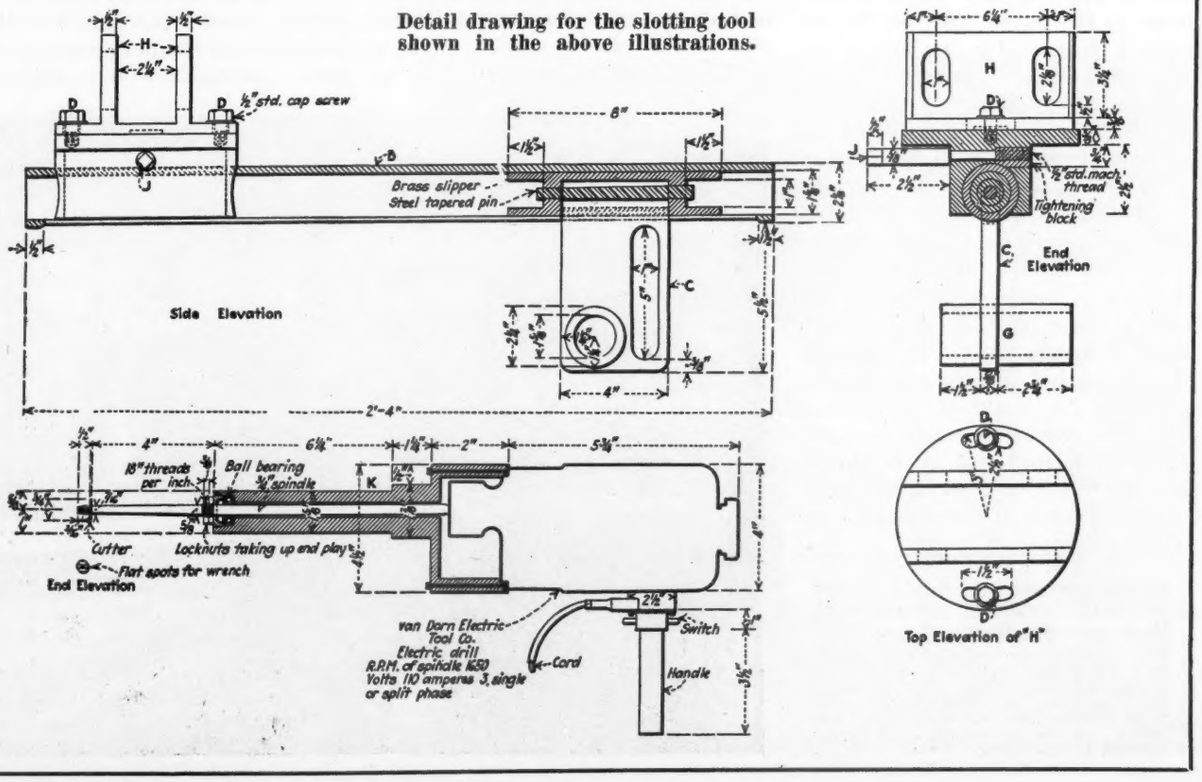
It is advisable to have a jet of compressed air so adjusted that the particles of mica and copper will be blown away from the armature to prevent this material falling in behind the commutator and at the same time make it easy for the operator to see the slot when the cutter is throwing particles of copper and mica toward him on the face of the commutator.

The advantage of undercutting commutators is that brushes which give very little friction and have no abrasive action on the commutator can be used.

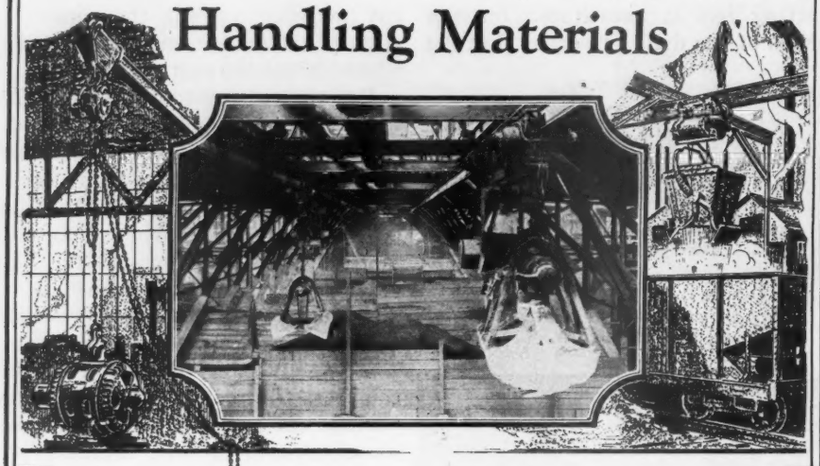
The friction loss with an abrasive brush operated at a pressure of 2 lb. per sq. in. on an average machine will be about 2.5 per cent of the machine's rating. R. H. N. LOCKYER.

Trail, B. C., Canada.

Detail drawing for the slotting tool shown in the above illustrations.



Handling Materials



Better ways to transport and handle raw and finished parts in and around the works will be discussed in this section.

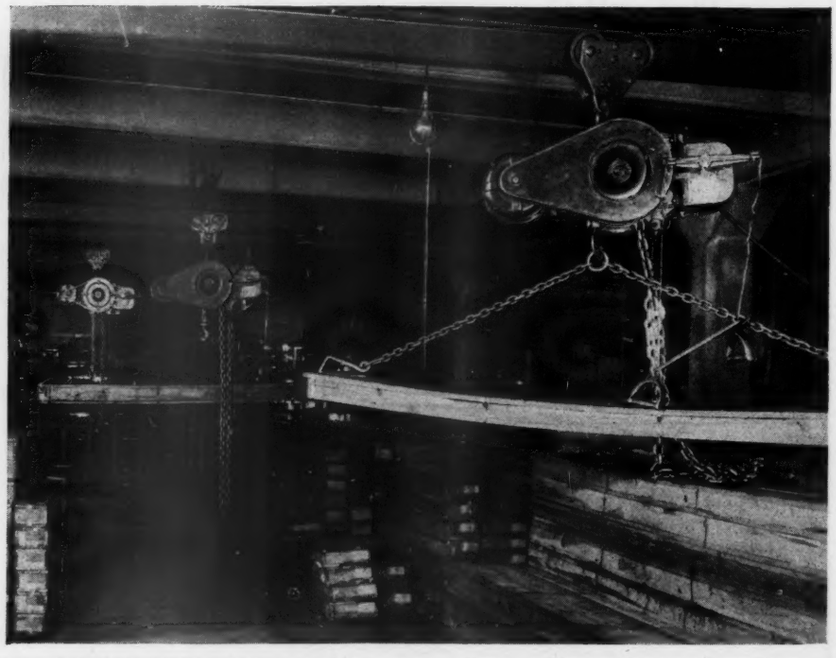
Two Men Do Four Men's Work in a Steel Warehouse With the Aid of Electric Hoists

IF THE boxes of steel received by the Steel Sales Corporation at their Chicago warehouse were to be handled by hand, a gang of four men would be necessary, as the boxes weigh from 350 to 800 lbs. each. However, two 1-ton and one ½-ton Yale & Towne electric hoists enable two men to do the warehousing of steel, which is received in carload lots, unloaded onto hand trucks, taken to the second floor on the elevator and wheeled to the hoist which is to transfer it to the proper pile.

Each hoist travels the length of the building on an overhead I-beam and gets its power from an extension cord suspended in loops from a wire stretched the full length of the building, as can be seen on the second hoist. As the building is about 150 ft. long, it would make heavy handling to drag the full 150 ft. of cord along with the hoist. To overcome this, the outlet box for each hoist is placed at the center of the building and two extension cords are provided—one for each direction—so that in whichever end of the building the hoists are operating, they have only 75 ft. of cord attached. Crossover aisles are left at each end and at the center of the three rows of boxes piled crossways. Placing the truck of steel at either the center or end of the pile makes it unnecessary to use the travel of the hoist for more than about 40 ft., which speeds up the handling.

The special hooks also speed up the handling because they can be attached quickly. For taking boxes out of the pile a special ice-tong grab-hook, which seizes the box by the sides instead of the ends, is sometimes used, as it is more easily handled by one man than is the long chain. An extension of each I-beam runs out over the alley so that boxes of steel can be loaded on the wagons or motor trucks directly from the hoists.

The hoists are hand-operated with electric lift floor-controlled and are made by the Yale & Towne Manufacturing Company, Stamford, Conn.



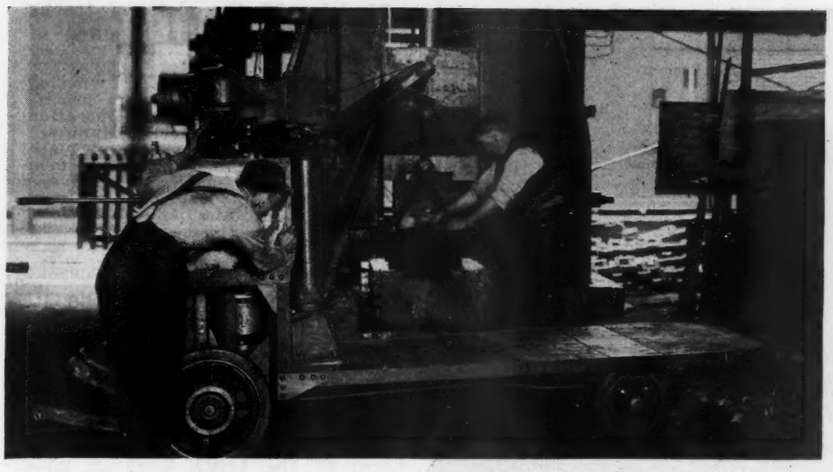
Eight hundred pound boxes of steel are easily handled by two men with these electric hoists.

One man can handle the boxes with this hoist but two men can adjust the hooks more easily and speed up the handling by working together. A simple method of decreasing the "drag" of the extension cord is described in the item.

Crane Truck Speeds Up the Changing of Forging Dies

ORDINARILY in shops with large forging hammers special rigging must be set up each time the dies are changed. Because each hammer is constructed differently, an individual rigging is required for each change. This makes considerable hand work and is dangerous unless great care is exercised in setting up the rigging. Overhead cranes, if any are installed, cannot be used economically for this work, as they would be tied up for too long a period.

With this special rigging it formerly required four to five men about a half day to change a die on a large forge hammer. At the plant of the Cleveland City Forge & Iron Company, two men—the truck and the hammer operators—now change a set of dies in less than two hours by using the Elwell-Parker storage battery crane truck shown in the illustration on the next page. In addition, it is much safer to handle the



Two men change a die in two hours.
Formerly four or five men put in a half day in changing these forging dies. The crane truck not only saves time, but decreases the likelihood of accidents It also carries the die to and from storage and does other heavy handling and hauling around the works. Notice the trip which prevents raising the load too high.

heavy dies by the crane than by temporary rigging, the safety of which depends upon the men erecting it. With a crane truck the whole problem is confined to the choice of the proper hooking device to lift the heavy die. In this case an ice-tong grab was considered to be the most suitable.

The hoist and truck not only change the die but take the old die to the storeroom, place it in storage and bring back the new one. A big advantage is that the crane is available for all heavy lifting in any part of this work. In addition, the crane truck is used for handling trays or steel barrels of small forgings to the trim shop and pickling department. The crane picks up the heavy barrel or tray, swings it onto the truck platform, carries it to its destination and lifts it off at the end of the trip quickly and safely.

The hoisting mechanism is operated by a separate motor but receives its power from the same battery that supplies the power for the propelling motor. The crane column revolves 180 degrees and is supported on ball bearings in a heavy steel pedestal which is firmly bolted to the steel flooring and heavy structural center sills extending from driving to trailing axle. Later models of this same truck have a longer boom, which can be elevated, and a heavier lift, since the battery compartment revolves with the crane and acts as a counterweight. The truck is four-wheel steer and is operated by one man. The large diameter rubber-tired wheels enable the truck to be operated on dirt, cement, brick or wood-block flooring. Even with the hard service in a forge shop, where the truck occasionally runs over a piece of hot iron, the tires last about a year. With less severe service the life is longer. The Elwell-Parker Electric Company, Cleveland, Ohio, manufacture these trucks.

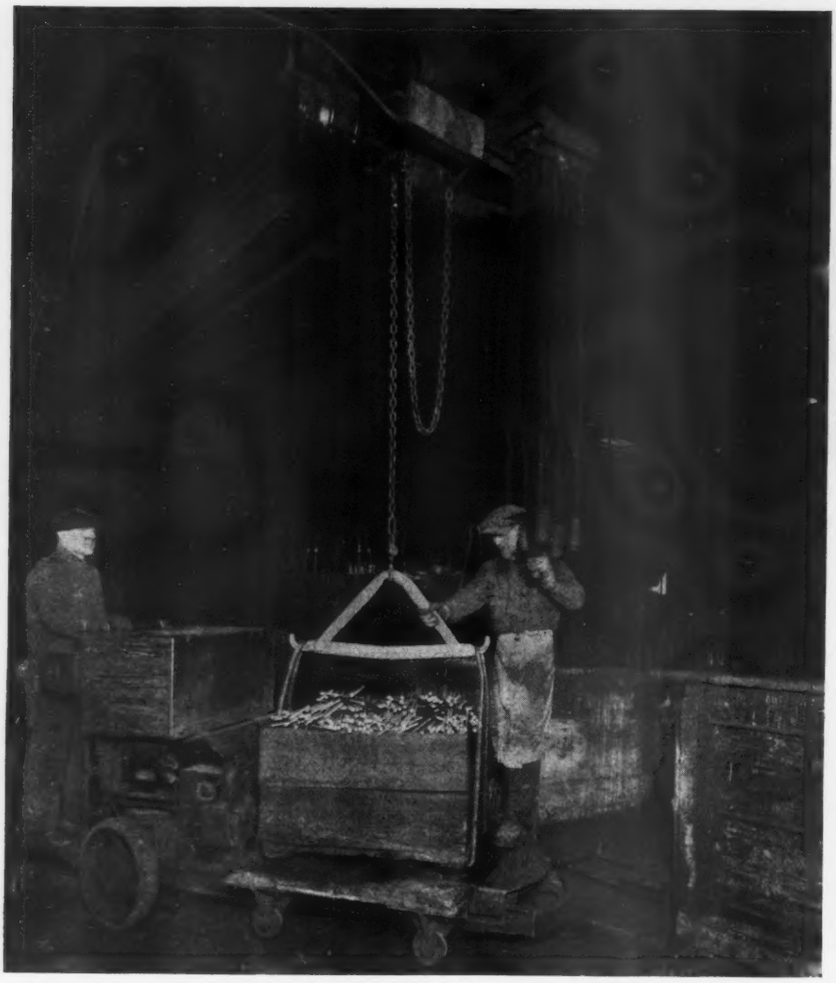
Portable Bag Piler Reduces Six-Men Gang to Two Men

PILING bags is a heavy task and when done by hand requires at least one or two men to each three or four feet in height, depending upon the weight of the unit to be lifted. For example, one man can lift and pile a 49-lb. sack of flour, but two men would be required to handle a 250-lb. sack of rye flour. Perhaps the most disagreeable part of hand piling, however, is that the men must lift each bag from the level of their feet—the most difficult position from which to lift.

At the warehouse of Lange, Merrill & Sommers, Chicago, Ill., five or six men were required before the Brown portable piler, shown in the accompanying illustration, was installed. Now two men unload and pile daily an average of over two carloads of flour and also take care of the teams and trucks which come to the warehouse. Thus the portable piler results in a direct saving of wages of three or four men at an expense for power of about $2 a month. One man is able to handle the bags at the top end of the piler, because he receives them waist high and simply swings them over onto the pile instead of having to bend over and lift them up.

The piler is driven by a 1-hp., 220-volt, a. c. motor and can be pushed by two men to any part of the warehouse. The four wheels are on castors, which enable it to be easily swung around into any position for

Piling two carloads of flour a day with two men.
Everything from 25-lb. paper bags to 250-lb. bags of rye flour are elevated to the top of the pile by this portable elevator. One man can handle the bags from the conveyor, because he does not have to stoop when he lifts.



Electric elevating-platform trucks and hoists speed up handling of material in process.

Elevating platforms and wheeled skids are used for carrying practically all the material from operation to operation at the Joslyn Manufacturing and Supply Company plant without rehandling or taking men away from the machines to give a "hand." A McCollum electric hoist lifts parts into and out of acid vats.

piling. To make it more easily moved, the foreman of the warehouse put in a special plug connection at the switch box so that the 100-ft. extension cord can be disconnected and does not have to be dragged around with the piler. When not in use, he winds up the cord on a home-made reel at the plug board, which keeps it out of the way.

This piler is shown at its maximum elevation of 11 ft. 6 in., which is as high as necessary for this building. Machines are made which elevate to a height of 35 ft. This conveyor can be lowered to about 5 ft. so that it can go through doorways. It is seldom used below this height, as the lower tiers are piled from the floor by hand. The conveyor is raised or lowered to fit the height of the pile by turning a crank. The bag piler chain conveyor can be reversed by a two-way switch so as to lower the bags from the pile, but in handling flour it is quicker to roll the sacks down than to use the conveyor. The piler is made by the Brown Portable Conveying Machinery Co., Chicago, Ill.

Handling Two-Ton Loads on an Elevating-Platform Truck

WHEN the product is heavy the problems encountered in transporting it about the plant are many and varied. This was the case at the Joslyn Manufacturing and Supply Company, Chicago, Ill., before two motor-driven elevating-platform trucks were installed. In this plant steel parts are fabricated and galvanized and, as a matter of economy, must be moved from one operation to another in large quantities.

Formerly materials were transported in 4-wheeled trucks pulled by hand. Frequently the two or three men assigned to this work could not move the load and called men away from the machines to help them.

Now, two two-ton Automatic electric elevating-platform trucks do all the moving of materials. All parts are put in tote boxes after each operation and placed on a platform or skid. These skids, one of which is shown on the truck in the accompanying illustration, are provided with four wheels so that they can be pushed around by hand if necessary.

In the case illustrated the steel rods, after being threaded at each end, are placed in a special wooden tote box with a bale or handle so that it may be hoisted into and out of the acid vats. The elevating platform of the truck slips in underneath the skid and is then raised 3½ inches by a separate motor.

Special 4-wheeled trucks are used for carrying bars and rods. These trucks are coupled up by a chain to the electric truck and hauled to their destination. In addition, other types of platforms or skids are used for special purposes. One, for example, is used at the shears and at the bolt heading and threading machines to hold the steel rods. It is about 4 ft. long, 18 in. wide, and 2 ft. high, with uprights at the end, and a base low enough to be lifted by the truck. It enables the operator to pick up or lay down the rods without stooping. In forming the head of a bolt or lag screw, a loaded skid is picked up at the shears and placed in front of the furnace. The furnace man places the short steel rods in the furnace and when they are hot passes them one at a time to the upsetter. When the head is upset the operator places them on another skid, so that they will be convenient for handling at the threading machine.

When the parts are packed the boxes or kegs are placed on one of these flat-topped skids on wheels and carried directly to the warehouse or to the shipping platform.

These trucks are of 4,000 lbs. capacity and were made by the Automatic Transportation Co., Buffalo, N. Y. They have three speeds ranging from 1 to 6 miles per hour, forward and reverse. The 4-wheel steer enables the driver to get into restricted spaces to pick up or deposit a load. Power is supplied by Edison storage batteries which are charged each night. Ordinarily only one truck is in service at a time but both are available. Maintenance cost is low and mechanical troubles are negligible, inasmuch as the trucks are thoroughly overhauled once a year.

Elements of Good Foundry Lighting

(*Continued from page* 168)

By referring to the curves in Fig. 3 the size of lamp to be used can be determined. From the nature of the work to be done, the desired intensity is determined. This value is then located on the vertical scale of the curves. The area to be lighted by each unit (determined from the spacing) is then located on the horizontal scale. The nearest curve to the meeting point of these lines then gives the size of lamp to be used. If this point comes between two curves the one higher should always be chosen in order to allow for decrease in efficiency due to dust and dirt collecting on the lighting equipment.

The use of the curves can best be illustrated by a typical example. Let us take the case of the foundry layout shown in Fig. 4. The dimensions are 80 ft. by 210 ft. and the highest possible mounting height for the units is 40 ft. above the floor. In order to install a system in which spacing and mounting height are approximately equal, and at the same time obtain a symmetrical layout of units, it is decided to mount two rows of units 40 ft. apart. In each row there will be 7 units 30 ft. apart mounted 40 ft. above the floor. Thus each unit illuminates an area of 40 ft. by 30 ft. or 1,200 sq. ft.

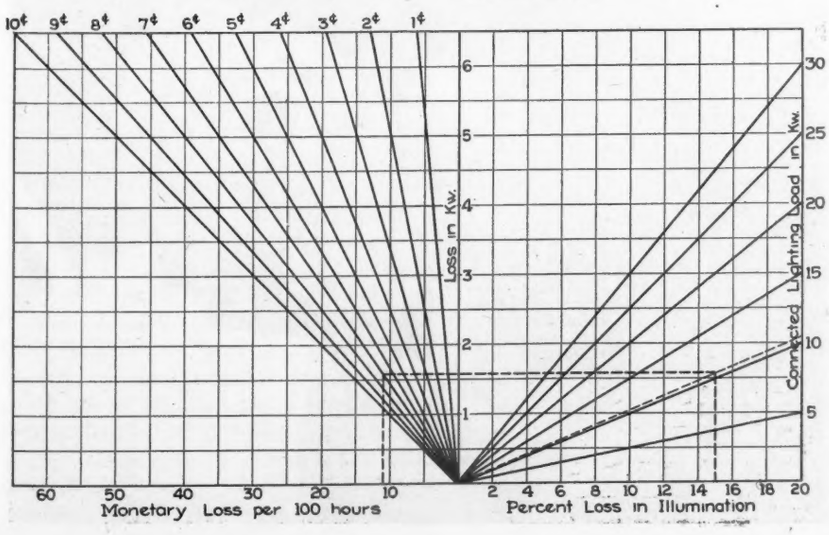
Large pieces are to be cast which call for little distinctness of detail and an intensity of about 4½ foot-candles is adequate.

Having obtained these data, turn to the curves in Fig. 3 and follow up a line from the point 1,200 sq. ft. until it meets a horizontal line drawn in from the intensity of 4½ foot-candles. These are found to meet just below the curve of the 750-watt lamp. The 750-watt lamp is therefore chosen and is found to give an intensity of 4.7 foot-candles over an area of 1,200 sq. ft. Thus the equipment suitable for this foundry will be 14 750-watt clear Mazda C lamps equipped with "R. L. M. Standard Dome" reflectors, spaced and mounted as shown in Fig. 4. In Fig. 5 the resultant illumination from this system is shown. The absence of shadows and the evenly distributed light shows that the system decided upon was the proper one.

In Fig. 6 another foundry is shown lighted by 300-watt Mazda lamps in "R. L. M. Standard Dome" reflectors spaced 10 ft. apart in two rows 40 ft. apart and mounted 40 ft. above the floor. Here the roof construction was of such a nature that it was deemed advisable to use smaller units with a closer spacing of adjacent units in the same row. Fig. 7 shows the excellent illumination obtained from this system, the actual intensity obtained checked with the value predetermined for the installation from Fig. 3.

Fig. 8. Chart for determining value of wasted light due to lack of maintenance.

In using this chart find the decrease in foot-candles due to dust and dirt in percentage of original intensity. Then locate this percentage on the horizontal scale at the right and draw a vertical line until it strikes a diagonal corresponding with the value of total connected lighting load in kw. Then draw a line horizontally from this point to the diagonal line corresponding with the rate in cents per kilowatt-hour paid for electrical energy and from this point draw a vertical line downward to the scale "Monetary Loss for One Hundred Hours," which shows the loss in dollars due to wasted light from deposits of dirt and dust on lighting units.


10¢ 9¢ 8¢ 7¢ 6¢ 5¢ 4¢ 3¢ 2¢ 1¢
Loss in Kw.
Connected Lighting Load in Kw.
60 50 40 30 20 10
Monetary Loss per 100 hours
2 4 6 8 10 12 14 16 18 20
Percent Loss in Illumination

Mounting Lighting Units Below Cranes

Often a traveling crane is located so close to the roof that lighting units cannot be mounted in the space above. In such foundries the use of the angle type steel reflector with Mazda C lamps mounted below the crane on the upright supports is recommended. Units should be mounted on each side of the section at a height approximately equal to ¾ of the width of the section and should be spaced a distance equal to ½ the width. With lighting units so spaced and mounted an even distribution of light will result over the entire floor. The hanging height will be such that the light from two opposite units will sufficiently overlap to prevent a low intensity in the center of the section. The values given in Fig. 3 apply, with a fair degree of accuracy, to the side lighting system.

In Fig. 2 is shown a center bay illuminated by this system. The lighting units are fastened to every other upright support which are spaced on 10 ft. centers and are mounted 30 ft. above the floor. Each unit consists of a 300-watt Mazda C lamp, equipped with an angle steel reflector. The resultant average illumination from this system is 4.5 foot-candles.

The side bays of a three-section foundry are often used for the molding of small parts and for core-making. Work of this nature requiring much distinctness of detail, demands light of a high intensity. The castings are small and the mold must be made with great care if spoilage is to be kept low. As a result the molder demands sufficient light to inspect his molds as they are made.

The side sections of the foundry, the floor plan of which is shown in Fig. 2, presents a problem of this type. The molders' benches are located along the walls in front of the windows and the molding machines along the line of upright posts. At one end of the right side section is located the core making department with the baking ovens at the end of the building.

Here the system used is known as localized general lighting, that is, the lighting units must be placed relative to the work. By arranging two rows of units in each side section, one row spaced 5 ft. in from the outer wall over the edge of the bench and the other 5 ft. in from

the row of upright posts over the molding machines and with a spacing of 10 ft. between every two units in the same row, the light is directed down upon the work with the highest intensity at the point where the work is being carried on and a low intensity over the space between the benches and machines, where the sand is piled and the completed molds are placed.

As stated previously, work of this character requires an intensity of light from 6 to 12 foot-candles. The area lighted by each lamp is found to be approximately 100 sq. ft. Fig. 3 shows that a 150-watt Mazda C lamp will give an intensity over this area of 8.5 foot-candles. This intensity is considered sufficient for the work in these sections and therefore if 150-watt Mazda C lamps equipped with "R. L. M. Standard Dome" reflectors are spaced as shown and mounted 15 ft. above the floor, illumination of a sufficiently high intensity for the work carried on in these bays will be provided.

In the same manner any foundry, no matter whether its products are castings weighing hundreds of pounds or small parts of delicate machines, may have its proper lighting system determined. A little commonsense together with a little engineering knowledge in laying out an adequate system of lighting will often result in a material saving in operating costs.

The Importance of Cleaning Reflectors

The benefits of the best possible lighting system will be greatly decreased through lack of maintenance. Even in the cleanest of surroundings a lighting system will gather dirt and dust and should be cleaned at times. In foundries where a dusty atmosphere is always present, maintenance should be more carefully attended to. Many industrial plant men disregard this fact entirely and actually believe that they are being economical by not spending the money for cleaning the lighting units. To disprove their theory, let us take an example to show what they are losing.

The foundry shown in Figs. 4 and 5 obtained an average intensity of 4.7 foot-candles when the system was installed. After one month of operation readings were taken and the average was found to be 4.0 foot-candles. Thus a decrease of 0.7 of a foot-candle or 15 per cent of the illumination had occurred in one month. The lamps had been burned 100 hours during that time. The total lighting load was 14×750 watts or 10.5 kw. and the rate paid was $0.07 per kw. hr.

The value 15 per cent is now located on Fig. 8 on the line designated as "Per Cent Loss in Illumination." From this point a line is extended up until it meets the diagonal line corresponding to a "Connected Load" of 10.5 kw. Then a horizontal line is drawn over to the diagonal line marked 7c. From this point a vertical line is dropped until it meets the line marked "Monetary Loss per 100 Hours." The value here is found to be $11.00. That is, a loss of $11.00 has been experienced due to the fact that 15 per cent of the power used and paid for, produced light which was wasted on the dirt collected on the lighting equipment.

If a laborer had been paid 50 cents per hour by the company and he had spent one-half hour in cleaning each lighting unit, the total cost per cleaning of the entire system would be 14×½×$0.50 or $3.50. Thus the lighting units could have been cleaned every 10 days or 3 times a month. By these frequent cleanings the lighting system can be maintained at a much higher efficiency.

Plant managers do not tolerate dirty tools and dirty machinery, but the lighting system, which is just as effective in keeping production at its maximum efficiency, is often allowed to drop to a very low point of efficiency through this lack of cleaning.

When Motors Are Operated 24 Hours a Day

(*Continued from page* 171)

Griffin oil is heavy, having a consistency near that of cylinder oil. It is used in all bearings except those of the vertical motors used in connection with a set of Fuller grinding mills, for which a light Red engine oil is used. As an aid to lubrication, heavy brass oil rings, as heavy as will go in the bearings, are substituted for the lighter rings supplied with new motors at the time they are received in the plant.

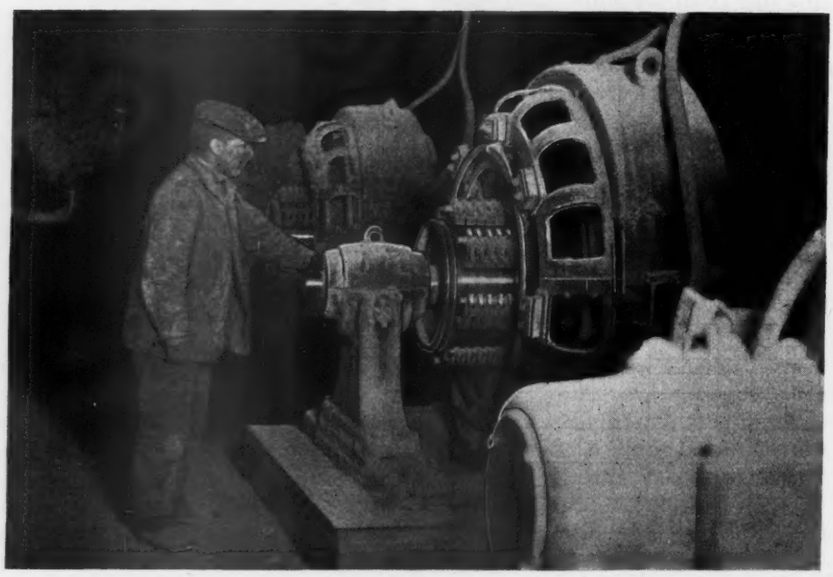
The oil in the bearings is changed only when the bearings begin to heat or when new bearings or a new armature is installed. The slow-speed tube-mill motors, rated at 250 hp. and running at a speed of 200 r.p.m., have the oil changed completely only about once in two years. Other motors subjected to more severe service wear out their bearings in a period of around two weeks and so have an oil change, together with the changing of bearings, at this frequency.

Duties of Inspector on Third Shift

Duties assigned to the inspector on the third shift include only the making of three complete inspection

Inspecting 250-hp. mill motor from commutator end.

The inspector has his hand on the bearing and at the same time is looking through the air gap at the top of the armature. Hot bearings are detected by feeling and worn bearings are judged by the air gap inspection. The air gap is inspected under each pole of the machine, and the inspector feels both bearings. Visual inspection is made of the brushes, switches and starting boxes on each visit to each motor.



rounds. This period is the hardest one of the day to work, and, consequently, no duties aside from inspection and the necessary emergency brush changes, etc., are assigned. The man on the third shift notifies the chief electrician in the morning concerning any equipment needing immediate attention before he goes off duty. Thus it is possible to start in immediately in the morning on any work that is pressing.

Aside from the chief electrician and the three inspectors already mentioned, the maintenance crew consists of an assistant chief and four men. These men change armatures and bearings, wind armatures and field coils, prepare bearings, refill fuse cartridges, bush and turn armature shafts, make and repair starting boxes, and do all other repair and maintenance work on the electrical equipment.

Repair Renewals and Parts

Coils for rewinding armatures are made in the shop. The separate parts of each coil are shellacked and clipped together before being wound with cotton tape. After the tape (half lapped) is in place the entire coil is dipped in Armlack, and after the armature is completely wound it is rolled in a trough of shellac and then air dried. Field coils, after being wound with tape (two layers half lapped), are immersed in shellac for half an hour and then allowed to dry in the air.

Bearings are made of Sterling babbitt for the smaller motors comprising about 80 per cent of the entire installation. Bearings for the other motors are made of Lumin metal, except in the case of the top bearings of the vertical motors and the bearings in one end of some kiln motors, which have Ahlberg ball bearings. For operating kilns, some surplus vertical motors are used, but with the shafts horizontal and with the original type of top ball bearing still in place. Lumin metal is used for the remaining bearings on the kiln motors and the vertical motors. It is found, in general, to give the best service with the larger and slower speed motors.

In order to provide for renewals with the least possible delay, a stock of about 60 completed bearings is maintained at all times. The bearings are made up in cut steel shells so that they can stand considerable rough treatment without breaking.

Battery operated tractor used for light hauling.

A total of eleven tractors are used in this service, that have been in constant use for eight years. They are charged at night and are used from eight to nine hours per day. The service to which they are subjected is anything but easy.

Moving 300 Tons of Material Daily

(*Continued from page* 186)

for drying, and then on again for another dip. A third dip is given before the finished product is ready for shipment or the warehouse. The overhead trolley system goes directly to the warehouse and, where required, the trolleys can be run onto elevators for transportation to the upper floors of the warehouse and assembly building.

Certain small parts that are made up in advance for stock are stored in wooden boxes that are moved into the stockroom on the wheeled trucks. These boxes are provided with iron rings to facilitate handling by means of a small hand-operated crane. Each box is tagged to show the article and exact quantity that it contains.

This plan of storage eliminates the loss or miscarriage of small parts that might otherwise remain in stock for a considerable time.

Battery operated locomotive used for heavy hauling.

Four of these units are used to handle small trains of industrial cars loaded with pig, scrap and coke. They haul this material to the foundry weighing floor.

Trade Literature
you should know about

The Martindale Electric Company, 11738 Detroit Avenue, Cleveland, Ohio—A circular describing the "Imperial" commutator stones, an artificial stone for grinding commutators, is being distributed. This also lists the other products of this company—commutator slotting tools, cyclone blowers, insulating varnishes and portable electric heaters.

Sprague Electric Works of the General Electric Company, 527 West Thirty-Fourth St., New York City—The research type of "Sprague" electric dynamotor is described in Bulletin No. 48,716 which is ready for distribution.

The Findlay Electric Porcelain Company, Findlay, Ohio — A catalog, "Standard Electrical Porcelain," describes with many drawings and illustrations this company's line of knobs, cleats, switch bases and other porcelain parts. The last page contains two useful tables, one giving the dimensions, gage and so on of standard steel wire nails, and the other similar data on screws.

Mathews Gravity Carrier Company, Elwood City, Pa.—The use of gravity and power-driven elevating sections of conveyor systems for handling material in numerous industrial plants is illustrated in a general catalog issued by this company.

The Ideal Electric & Manufacturing Company, Mansfield, Ohio—Squirrel cage and slip ring induction motors are described in Bulletin 103 issued by this company. Several interesting features of motor design and operation are discussed in this bulletin, such as: An explanation of the Heyland diagram, the determination of the amperes per terminal, belt and pulley calculations, and horsepower and torque equations.

The Esterline-Angus Company, Indianapolis, Ind.—Bulletin 322 contains a brief description of the entire line of Esterline-Angus portable and stationary recording and indicating meters.

The Climax Motor Devices Company, Chagrin Falls, Ohio—Cord disc flexible couplings which are noiseless and require no lubricant for transmission of from 1 to 6 hp. per 100 r.p.m. are described in a folder put out recently by this company.

Maloney Electric Company, St. Louis, Mo.—Catalog No. 215 contains 48 pages of interesting information on the construction, installation and operation of transformers which will be of value to anyone using transformers; of special interest are the several pages given to instructions on their installation and care.

The Electric Motor & Engineering Company, Canton, Ohio—Price lists for catalog 3 are being distributed. These lists give the dimensions and prices for practically every size and style of steel box used in electrical construction work.

Jenkins Bros., 80 White Street New York City—A leaflet recently issued describes the Jenkin's air gun for removing dust and other light foreign matter by means of compressed air. A special feature is the renewable disc, which forms a perfect contact in the seat and takes up the wear of frequent use.

Tindall & White, Inc., 329 East 22nd Street, New York City—A circular is being distributed describing the Perfection shade manufactured by this company. This is furnished in two sizes, one for individual local lighting and the other and larger size is for local and general lighting. It is characterized by a metal dome, porcelain-enameled in French gray, surmounting a white-enamelled metal "tongue" or nesting reflector.

Roth Brothers & Company, Adams and Loomis Street, Chicago, Ill.—A series of bulletins describing its several types of standard and special duty motors has been issued by this company. Particular emphasis is placed on motors designed especially for elevators, printing presses and pumps, as well as standard 40 degree general purpose motors. One of these bulletins describes special grinders and polishers with built-in motors.

The Ideal Electric & Manufacturing Company, Mansfield, Ohio — Bulletin 102 describes direct current motors and generators built by this company and gives a discussion on several of the features of the different types and designs. Some of the interesting subjects covered are: Advantages of different types of armature winding, characteristics of different types of field coils, why interpoles are used, causes of injurious sparking, and brush characteristics.

The Trumbull-Vanderpoel Electric Manufacturing Co., Inc., Bantam, Conn.—Bulletin 11 describes the line of Mason safety switches put out by this company which are particularly adaptable for mounting on motor-driven machines. These switches cannot be left partly in contact as there is a positive break and so do not arc or burn contacts. Tables giving dimensions and weights and motor wiring data form a valuable feature of this bulletin. Specifications for inclosed switches of various types are also included.

Thomas Flexible Coupling Company, Warren, Pa.—A complete description, including specifications and dimensions of the various single, double and mill types of flexible couplings from 2 to 10,000 hp., is given in a recent catalog.

Shepard Electric Crane & Hoist Company, Montour Falls, N. Y.—Bulletin 61 gives detailed descriptions of the mechanism and numerous illustrations of electric traveling cranes, both floor and cage operated, installed in various industries. A part of this bulletin covers the cage-operated monorail electric hoist or aerial railway. These are built in capacities of from 500 lbs. to 10 tons. Grab buckets or magnets may be used as well as chains to handle loads. Numerous diagrams illustrate the details of the construction and electric control.

Gamewell Fire Alarm Telegraph Company, Newton Upper Falls, Mass.—A new series of bulletins describing the various types of fire alarms and auxiliary equipment has recently been issued by this company. Gongs, repeaters, registers, switchboard and battery equipment for use in connection with alarm systems are included.

B. F. Sturtevant Company, Hyde Park, Boston, Mass.—Bulletin No. 246 describes the "Sturtevant" generator cooling apparatus.

The Delta-Star Electric Company, 2433-59 Fulton Street, Chicago, Ill.—Bulletin 37, containing 64 pages, covers outdoor substations for all voltages up to and including 66,000 volts.

Portable Tool Box

(*Continued from page* 187)

Strips of ⅜-in. wood are used to divide the bottom part into small boxes to hold tools and supplies. As the sketch shows, there is a long compartment on the center of the bottom for long tools such as hammers, files, die stocks and so on. At the front and back of the box are smaller compartments for nails, screws, fuses, cleats and such material. A shelf is put in half way up the back of the box for holding a complete line of condulets and other pipe fittings. This shelf is divided into small bins by means of ⅜-in. wood partitions.

On top of the box a vise is bolted, as the photographs show. At each corner of the top a small wooden block has been placed. When conduit is piled on top of the box these blocks keep it from rolling off. A fairly good load of conduit can be carried in this way.

It is necessary to keep the truck from moving when working on conduit. For this purpose one of the wheels is run into a grooved block.